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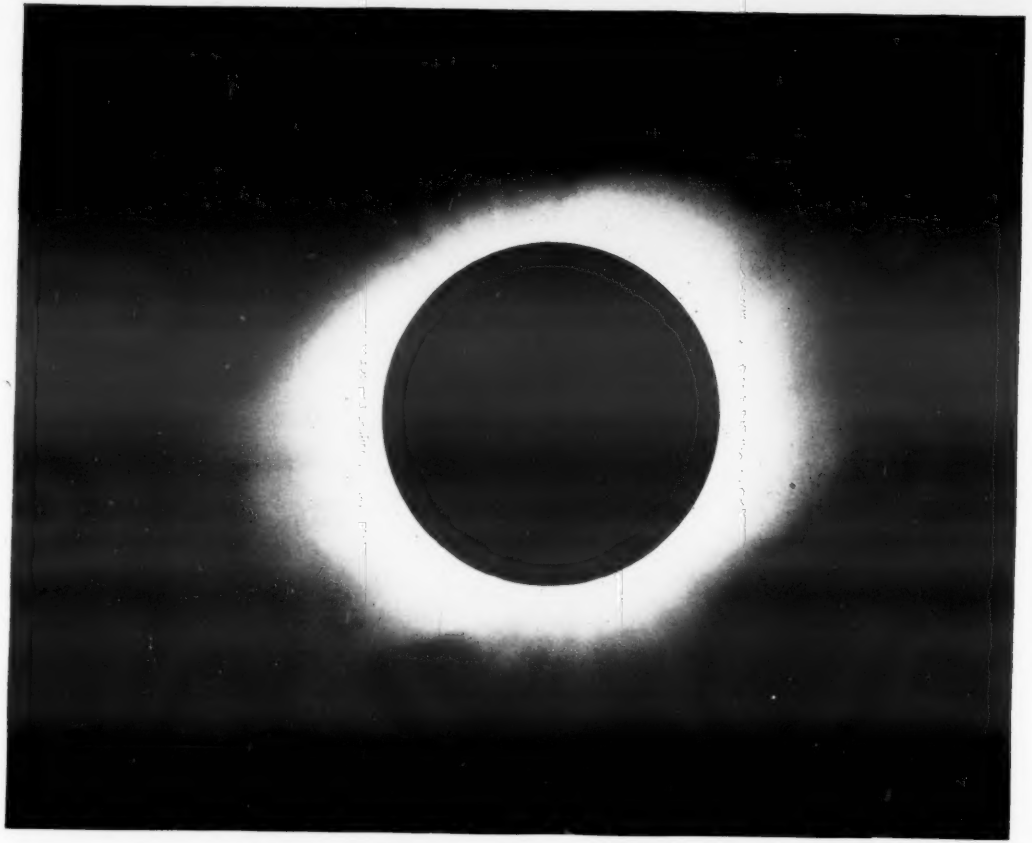


NEGATIVE NO. 5 TAKEN AT FORT DE KOCK. G. H. Peters, Photographer.

Exposed from the 43d to the 103d second of totality. The delicate details are lost in reproduction.

NEGATIVE NO. 3 TAKEN AT PORT DE KOCK.
Exposed from the 43d to the 103d second of totality. The delicate details are lost in reproduction.
POPULAR ASTRONOMY, No. 91.

Popular Astronomy.

Vol. X No. 1. JANUARY 1902. Whole No. 91.

THE NAVAL OBSERVATORY ECLIPSE EXPEDITION TO SUMATRA.

A. N. SKINNER.

FOR POPULAR ASTRONOMY.

Under an appropriation from Congress made available early in January preparations were made by the Naval Observatory to observe in the island of Sumatra the total solar eclipse of May 18, 1901. An expedition for this purpose in charge of Professor A. N. Skinner, U. S. N., embracing six of the Observatory staff and five scientists invited from other institutions, whose expenses were defrayed by the Naval Observatory, sailed from San Francisco on board the U. S. army transport Sheridan February 16 and arrived in Manila March 18. Transportation having been provided thence on board the U. S. gunboat General Alava, the party arrived at Emma Haven the port of Padang on the west coast of Sumatra on April 4.

On landing in Sumatra having been informed that the dry season was at hand we were naturally encouraged in our hopes that we should have a clear day for the eclipse, but the experiences of a few weeks taught us the precariousness of the weather as we witnessed copious showers at frequent intervals, in fact almost every day.

As a result of careful investigation into local conditions Professor Skinner decided to locate the main station at Solok 81 miles by railroad northeast from Emma Haven and a second station at Sawah Loento some nineteen miles beyond Solok to the eastward at the end of the railroad. These two stations were selected although about forty miles north of the central line of the shadow because difficulties of transportation precluded the selection of stations away from the line of the railroad. A third station was desired as near as practicable to the northern edge of the shadow and for this purpose Fort de Kock was selected which is about sixty miles north from Emma Haven on the railroad line. The actual distance from the northern edge of the shadow appears to have been somewhat less than ten miles.

THE SOLOK STATION.

Professor Skinner assumed immediate charge of the main station at Solok where were located the following instruments within the limits of a dismantled fort which was very courteously placed at the disposal of the Naval Observatory and the Smithsonian parties by Resident N. K. Derx:

1. A photoheliograph of 6 inches aperture and 61 feet focal length fed by a coelostat with a 15-inch mirror, the entire instrument being the property of the Yerkes Observatory in charge of Professor E. E. Barnard of the Yerkes Observatory.

2. A ten feet concave grating photographic spectroscope in charge of Mr. L. E. Jewell now of Johns Hopkins University assisted by R. H. Schops from the General Alava.

3. A flat grating photographic spectroscope used with a slit loaned by the Johns Hopkins University, in charge of Professor F. B. Littell, U. S. N.

4. A prismatic camera loaned by the Smithsonian Institution in charge of Mr. W. W. Dinwiddie of the Naval Observatory assisted by M. C. Suman from the General Alava.

5. A spectropolarigraph devised and furnished by Professor R. W. Wood of Wisconsin State University in charge of Dr. N. E. Gilbert of Hobart College, Geneva, N. Y., assisted by J. J. Few from the General Alava.

6. A photographic camera of 7.5 inches aperture and 114 inches focal length in charge of Mr. H. D. Curtis, Fellow of the University of Virginia.

7. A Voigtlander doublet of 6.25 inches aperture and 31 inches focal length.

8. A Clark doublet 3.25 inches aperture and 30 inches focal length.

Nos. 7 and 8 which were loaned by the Yerkes Observatory were mounted on an equatorial stand loaned by Mr. G. N. Saegmuller and placed in charge of Mr. G. E. Irving assisted by W. J. Cassidy and G. H. Getz from the General Alava.

Instrument 2, 3, 4 and 6 were fed by modified coelostats originally constructed for transit of Venus work.

At Solok clouds of varying density interfered with the work so seriously that only a few spectroscopic negatives of very doubtful value were secured; absolutely nothing was obtained with the photographic cameras. Professor Skinner and Mr. Curtis were able to observe the first, second and fourth contacts.

THE SAWAH LOENTO STATION.

The station at Sawah Loento in charge of Dr. S. A. Mitchell

G. H. Peters, Photographer.

NAVAL OBSERVATORY ECLIPSE STATION, FORT DE KOCK.

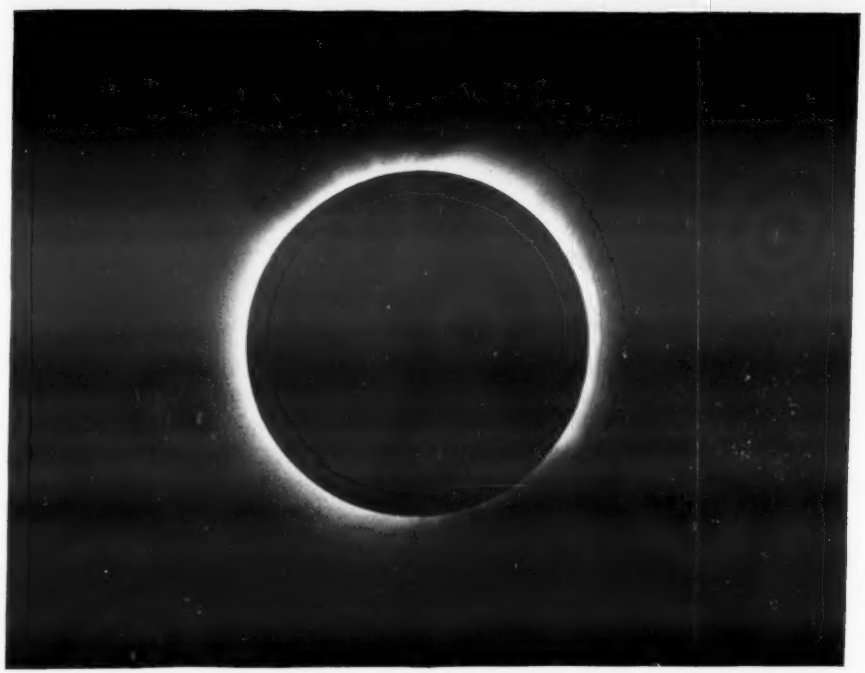
On the left is the 40 foot camera with its dark room. In the center the tent covering the concave grating spectroscope. The coelostat may be seen between these two instruments. The two other structures are a small dark room and a bamboo store room. This picture was taken about 15 minutes after 1st contact. The clouds are real.

W. W. Dinwiddie, Photographer.

NAVAL OBSERVATORY ECLIPSE STATION, SOLOK.

On the left is the flat grating spectroscope. In the center is the prismatic camera. On the right is the concave grating spectroscope. On the extreme right may be seen the earth rampert of the fort.

PLATE III.



C. H. Peters, Photographer.

NEGATIVE No. 4 TAKEN AT FORT DE KOCK WITH THE 40-FOOT CAMERA.

Exposed from the 28th to the 33d second of totality. The delicate details are lost in reproduction.

was located by courtesy of Controleur G. Sieburgh on an elevation about one mile from the village near the camp of the Massachusetts Institute of Technology and was provided with the following instruments:

1. A flat grating photographic spectroscope in charge of Dr. S. A. Mitchell of Columbia University assisted by C. W. Keeter from the General Alava.

2. A photographic camera of six inches aperture and 104 inches focal length in charge of Mr. René Granger of Cartersville, Georgia.

At Sawah Loento the clouds were somewhat less troublesome than at Solok permitting Dr. Mitchell to obtain six photographic spectra and Mr. Granger six photographs of the corona. A careful study will show how much the clouds detracted from the value of those negatives.

The Fort de Kock Station.

The station at Fort de Kock in charge of Professor W. S. Eichelberger U. S. N. was located on the artillery drill ground which was very courteously placed at the disposal of Professor Skinner by the military commandant Majoor T. H. Van Haeften. Here were mounted the following instruments:

1. A photographic camera of five inches aperture and 39 feet focal length in charge of photographer George H. Peters of the Naval Observatory assisted by A. L. Smith from the General Alava.

2. A 30 feet concave grating photographic spectroscope in charge of Dr. W. J. Humphreys of the University of Virginia assisted by W. A. Vanaken from the General Alava. This grating is the property of Mr. L. E. Jewell.

These two instruments were fed by a Brashear coelostat specially built for this work furnished with two ten inch silvered glass mirrors.

Judging from our experiences on the ground the chances for clear weather were much less than at our other two eclipse camps, but contrary to all expectations the sky was cloudless during the entire totality permitting Mr. Peters to secure ten negatives of the corona with the photographic camera, Dr. Humphreys six photographic spectra with the 30 feet concave grating and Professor Eichelberger, the times of second and third contacts.

Of the ten plates taken by Mr. Peters at Fort de Kock the following have been selected for reproduction: Plate 5 which was

exposed from the 43d to the 103d second of totality. On the original negative the corona can be traced rather more than a diameter from the limb. Plate 7, which was exposed from the 141st to the 144th second of totality, shows the chromosphere, prominences and inner corona. The negative shows clearly a coronal disturbance, which also appears on the other plates, near the eastern limb. This will probably be lost in reproduction. A view of the position at Solok and one of the station at Fort de Kock are given.

The Southern Comet.

An interesting feature of our stay at Solok was the discovery of a bright comet in the western sky on the evening of May 3, by Mr. Dinwiddie. Several photographs were secured with the Voightlander doublet on the evenings of May 5 and 6 by Professor Barnard and Mr. Curtis.

Valuable volunteer assistance was received from the following: Ensign Gilbert Chase, U. S. N., Cadet W. V. Tomb, U. S. N., Assistant Surgeon H. E. Odell, U. S. N., all officers of the General Alava, Mr. René Granger of Cartersville, Georgia, Mr. G. E. Irving Agent of the British and Foreign Bible Society in Sumatra, Mr. Melvin Munson of Padang. By courtesy of Lieutenant Commander W. F. Halsey Commander of the General Alava, we received the very efficient services of eight men from the ship whose names appear in connection with the description of the several stations.

The generous assistance which was afforded to our party by every Netherland official was in perfect accord with the marked courtesy with which we were received by His Excellency A. M. Joekes Gouverneur Sumatra's Westkust. The free transportation which was granted to the observers and their instruments over the railroad should be mentioned in connection with the name of Heer Th. F. A. Delprat, head of the railway system. U. S. Consular Agent C. G. Veth was untiring in his services at all times in our behalf.

The novel scenes we had witnessed during nearly two months and the pleasant remembrances of hosts of kind friends all crowded through our minds when sailing on the 28th of May the shores of Sumatra faded from our eyes.

Last month we printed an article by Professor E. E. Barnard of Yerkes Observatory on the Naval Observatory Eclipse Expedition to Sumatra. The above article by Professor A. N. Skinner was sent to us before Mr. Barnard's article was in print. Professor Skinner was delayed in getting his photographs mounted.—Editor.

THE TRANSFORMATION OF THE DIFFERENTIALS OF AREA AND VOLUME.

ASAPH HALL.

FOR POPULAR ASTRONOMY.

This transformation from rectangular to polar co-ordinates is generally done for the purpose of facilitating integrations. It was given first by Lagrange, and though it has since been worked out in a general manner by means of determinants it may be well to look at the simple method of Lagrange, which is sufficient for practical work. Let us change the differential of area

$$V \,.\, dx\, dy$$

to polar co-ordinates, having given

$$x = r\cos\theta; \qquad y = r\sin\theta$$

and V a function of x and y. We write

$$dx = P\,dt + Q du; \qquad dy = P'dt + Q'du$$

t and u are the new variables which are known functions of x and y, as well as P, Q, P′, Q′. We cannot multiply these values of dx and dy together to obtain the element of area, since the dx in the integral of $V \,.\, dx\, dy$ supposes that y is constant; or in order to compute dx we must take

$$dx = Pdt + Qdu; \text{ and } 0 = P'dt + Q'du$$

These equations give

$$du = -\frac{P'}{Q'} \,.\, dt; \qquad dx = \frac{PQ' - P'Q}{Q'} \,.\, dt$$

Eliminating dx the differential $V \,.\, dxdy$ will be in terms of y and t,

$$\frac{PQ' - P'Q}{Q'} \,.\, V \,.\, dy\, dt.$$

In order to remove dy we make $dt = 0$ in its first value, and have $dy = Q'du$; so that finally

$$V \,.\, dx\, dy = (PQ' - P'Q) \,.\, V \,.\, dudt.$$

As an example let us change the element $dydx$ to polar co-ordinates, having given

$$x = r\cos\theta; \qquad y = r\sin\theta.$$

From these equations,

$$dx = \cos\theta \,.\, dr - r\sin\theta \,.\, d\theta$$
$$dy = \sin\theta \,.\, dr + r\cos\theta \,.\, d\theta$$

Put $u = \theta$, $t = r$, and by comparison

$$\begin{aligned} P &= \cos\theta & Q &= -r\sin\theta \\ P' &= \sin\theta & Q' &= r\cos\theta \end{aligned}$$

and we have

$$PQ' - P'Q = r \qquad V = 1$$

so that we have $r \,.\, d\theta dr$, instead of $dxdy$.

Let the element of volume be $V \,.\, dx\,dy\,dz$, and the new variables be s, t, u. We write in a general form

$$\begin{aligned} dx &= P \,.\, ds + Q \,.\, dt + R \,.\, du \\ dy &= P' \,.\, ds + Q' \,.\, dt + R' \,.\, du \\ dz &= P'' \,.\, ds + Q'' \,.\, dt + R'' \,.\, du \end{aligned}$$

In this case we must compute dx by assuming y and z constant or the last two equations must be put equal zero.

These give

$$du = \frac{P'Q'' - P''Q'}{Q'R'' - Q''R'} \,.\, ds \qquad dt = \frac{P''R' - P'R''}{Q'R'' - Q''R'}\, ds$$

By substitution in the value of dx we have

$$dx = \frac{[P(Q'R'' - Q''R') + Q(P''R' - P'R'') + R(P'Q'' - P''Q')]}{Q'R'' - Q''R'} \,.\, ds \quad (1)$$

With this value of dx the element $dxdydz$ is expressed in terms of y, z, and s. In order to find dy we make $ds = 0$, and $dz = 0$, in the first equations because the variables are independent, and we find

$$dy = Q'dt + R'du \qquad 0 = Q''dt + R''du$$

Hence

$$du = -\frac{Q''}{R''} \,.\, dt : \qquad \text{and } dy = \frac{Q'R'' - Q''R'}{R''} \,.\, dt: \qquad (2)$$

The variables are now z, s and t; and to compute dz we make $ds = 0$, $dt = 0$, in the last general equation, and find

$$dz = R'' \,.\, du \qquad (3)$$

Multiplying together equations (1), (2) and (3) we have the value of $Vdxdydz$ in terms of the new variables, or

$$[P(Q'R'' - Q''R') + Q(P''R' - P'R'') + R(P'Q'' - P''Q')] \,.\, Vdsdtdu \qquad (4)$$

It will be noticed in both the area and volume that the coefficients in brackets have the form of determinants, and this suggests the generalization that has been made for n variables. As an example take the common formulas for transforming from rectangular co-ordinates in space to polar co-ordinates

$$x = r\cos\phi\cos\psi; \qquad y = r\cos\phi\sin\psi; \qquad z = r\sin\phi.$$

These equations give

$$dx = -r\sin\phi\cos\psi\,.\,d\phi - r\cos\phi\sin\psi\,.\,d\psi + \cos\phi\cos\psi\,.\,dr$$
$$dy = -r\sin\phi\sin\psi\,.\,d\phi + r\cos\phi\cos\psi\,.\,d\psi + \cos\phi\sin\psi\,.\,dr$$
$$dz = \quad r\cos\phi\,d\phi + \sin\phi\,.\,dr$$

By comparison with the general forms assumed for dx, dy and dz, if we put $s = \phi$; $t = \psi$; and $u = r$, we have

$P = -r\sin\phi\cos\psi$	$Q = -r\cos\phi\sin\psi$	$R = \cos\phi\cos\psi$
$P' = -r\sin\phi\sin\psi$	$Q' = \quad r\cos\phi\cos\psi$	$R' = \cos\phi\sin\psi$
$P'' = \quad r\cos\phi$	$Q'' = 0$	$R'' = \sin\phi$

The substitution of these values gives

$$P\,(Q'R'' - Q''R') = -r^2\sin^2\phi\cos^2\psi\cos\phi$$
$$Q\,(P''R' - P'R'') = -r^2\cos^3\phi\sin^2\psi - r^2\sin^2\phi\sin^2\psi\cos\phi$$
$$R\,(P'Q'' - P''Q') = -r^2\cos^3\phi\cos^2\psi$$

The sum of these gives the coefficient in (4); which is $-r^2\cos\phi$. We may change the sign to plus in the integrations, and we must substitute in V the values of x, y, z, in terms of ϕ, ψ and r. The element $V dx dy dz$ becomes

$$V\,.\,r^2\cos\phi\,d\phi d\psi dr.$$

It is curious to see how easily these transformations can be made by geometry. For the element of area draw two concentric circles around the origin with radii r and $r + dr$, and give a differential increment to the angle θ. We multiply $d\theta$ by r to reduce it to linear measure. We have a small rectangle whose sides are $rd\theta$ and dr, and its area is $rd\theta\,dr$, which we may use in place of $dx\,dy$.

For the element of volume draw two concentric spheres around the origin, with radii r and $r + dr$; and give differential changes to the planes which determine ϕ and ψ. Reducing the angular differentials $d\phi$, and $d\psi$, to linear measure we have a small rectangular volume, the sides being

$$rd\phi : r\cos\phi\,d\psi : \text{and } dr.$$

The product gives the element of volume

$$r^2\cos\phi\,d\phi\,d\psi\,dr,$$

which will replace $dx\,dy\,dz$.

GOSHEN, Conn., 1901, Nov. 13.

THE PERIOD OF REVOLUTION OF THE LEONIDS.

WILLIAM H. PICKERING.

For Popular Astronomy.

The former apparitions of the Leonid shower as given by Newton in *Silliman's Journal*, 1864, Vol. XXXVIII, p. 55, are 902, 931, 934, 1002, 1101, 1202, 1366, 1533, 1602, 1698, 1799, 1832, and 1833. To these we may now add 1866, 1867 and 1868. From the first and last of his dates Newton evolved the period of 33.25 years by the simple process of dividing the difference by 28. For his purposes this gave all the accuracy that he needed, but it is now well known that unlike the orbit of a planet, that of a comet is subject to large variations, owing to which the period may be shortened or lengthened by a period of several years. Indeed, if during an interval of one thousand years the period of any comet had remained absolutely uniform, it would be considered rather a remarkable circumstance. Thus, between 1456 and 1835 the five revolutions of Halley's Comet have a mean period of 75 years 11 months. The five preceding revolutions between 1066 and 1456 have a mean length of 78 years 0 months but no two periods are exactly the same. If we assumed a uniform period for the whole ten revolutions as has been done heretofore with the meteors, the error at the time of perihelion passage in 1456 would have amounted to 5 years 4 months.

Assuming Newton's uniform period of 33.25 years Stoney and Downing have computed that the present orbit of the meteors lies 100,000 miles inside that of the Earth at the node, and in this manner they have explained the failure of the expected shower to appear in 1899. If now it can be shown that the period of the meteors has changed, and that they are not now following that orbit, their explanation would seem to be unsatisfactory.

An examination of the recorded dates of the various showers shows considerable variation in the date of apparition. Thus in 1698 the shower came four years ahead of the proper time as based on the 33 year period. Ever since that date, however, as I pointed out in Popular Astronomy 1899, Vol. VII, p. 523, the appearance of the shower has agreed very closely with a period of 34 years, the mean dates being 1698, 1799, 1833, 1867. The next appearance was then predicted for 1901, with a possible second appearance in 1902.

The approach of the nights of November 14 and 15 of the pres-present year were therefore looked forward to with considerable

interest. Fortunately both nights were clear at Cambridge, and on the former the frequency of the meteors rapidly increased as the radiant approached the meridian, so that forty-nine leonids were counted by a single observer in forty-eight minutes between $16^h\ 30^m$ and $17^h\ 30^m$ E. S. T. This is twice the frequency noted in any recent previous year. The observations were then interrupted by dawn, but a rapidly increasing number of bright meteors seen in spite of the daylight led to the remark that a shower would probably be seen in California or the Philippines. The number of observers throughout the night varied from one to six, and altogether 450 meteors were counted of which 360 were leonids. The attention was fixed exclusively on the eastern sky. In 1898 on November 14 over 800 meteors were counted, but on that occasion the whole sky was watched, and we had nearly three times as many observers. Observations made on the night of November 15 of the present year resulted in a count of 147 meteors, of which 83 were leonids, thus showing that the maximum was clearly past. The count both nights was made under the direction of Professor O. C. Wendell.

A newspaper article just received states that a meteoric shower occurred just before dawn in Los Angeles, 385 meteors being counted in one hour by a single observer, many of them being seen to burst. During the great shower of 1866, 400 meteors were counted by one observer at the Greenwich Observatory, so it will be seen that the two showers were fairly comparable. It will be interesting to hear what, if anything, was seen in the Hawaiian Islands and the Philippines.

This year's observations would therefore seem to confirm the belief that the 33.25 year period must be abandoned, and that since 1698 the swarm has followed an orbit whose period is very nearly 34 years,

HARVARD COLLEGE OBSERVATORY,
November 16, 1901.

MOTION IN THE FAINT NEBULA SURROUNDING NOVA PERSEI.

C. D. PERRINE.

Photographs of Nova Persei were obtained with the Crossley reflector by Messrs. H. K. Palmer and C. G. Dall between February 24th and March 29th inclusive, all of short exposure. It was planned to make a long exposure of the region about the Nova, but this was not done until the nights of November 7th

and 8th, as the telescope was used for spectroscopic work during the summer months. An exposure of 4^h 19^m was secured on the night of November 7th, and 3^h on November 8th, making a total of 7^h 19^m. The exposure on the latter night was stopped by the fog, which had been in the canyons and valleys, rising around the mountain top.

I had hoped to give an exposure of ten hours, but as the storm promised to be an extended one I developed the plate on the following day. The seeing on the first night was excellent; on the second night it was only fair to start with, and towards the end became very bad at times. The resulting negative is not entirely satisfactory, the star images being somewhat elongated owing to the unstable mounting of the instrument, and blurred by the intervals of poor seeing. The large mirror has not been silvered since it left England in 1895 so that considerable light is lost at this surface.

The plate used was a Seed 27 of a fresh emulsion. The negative shows but little fogging from the general illumination of the sky. Upon it are to be seen the nebula south of the Nova discovered by Professor Max Wolf* and most of the nebulosity shown on the photograph and drawing of Mr. Ritchey's negative.† The strongest nebulosity is very near to the Nova, adjoining it on the south and west. This mass is elongated in a general direction south and east and is nearly two minutes of arc in length. There are a number of very faint wisps to the south of the Nova for a distance of 6′, the outer ones being the stronger. These outer wisps are concave toward the Nova, on the arc of either a conic section, other than a circle, or of a spiral; but as only the outer end can be traced, the form of the curve remains undetermined. To the north of the Nova, and seeming to join it, there is a faint mass of nebulosity, while further away in the same direction are traces of other masses, but they are too faint to make any structure certain. The image of Nova on the negative is 40″ in diameter.

A comparison of this negative with the reproduction from the photograph secured by Mr. Ritchey with the two-foot reflector of the Yerkes Observatory on September 20th, reveals some remarkable changes of position in the more pronounced condensations. Only four of these condensations are sufficiently defined to make determinations of position certain enough for purposes of comparison.

* *Astronomische Nachrichten*, No. 3736.

† *Astrophysical Journal*, XIV, 167.

The accompanying diagram was made by taking a tracing of Mr. Ritchey's photographic reproduction (the fainter stars are not included), the centers of figure of the four condensations being indicated thereon by dots. The centers of figure of these same condensations were then indicated in a similar way on the back of my negative, and transferred to the tracing.

The four masses of nebulosity used are designated by the letters *A*, *B*, *C*, *D;* the positions which the centers of figure occupied on September 20th, as shown in the reproduction from Mr. Ritchey's photograph are occupied by the left-hand or northwest end of each of the short lines; the positions on November 7-8 are occupied by the right-hand or southeast ends of the lines.

The line drawn between these positions for each condensation indicates the direction and amount of motion in the interval of 48 days. Condensation *A* is much the best adapted for accurate measurement, from its greater strength and from its forked appearance; condensations *B* and *C* are not quite so good for measurement as *A*, but still are very determinate; but while condensation *D* is the brightest of all, it is large and so near the image of the Nova as to make its amount and direction of motion somewhat uncertain.

It will be seen that the displacements agree well, and amount to about 1½′. The directions are not so consistent, and could perhaps be explained by irregular motions in the nebulous mass, by a general translation of the nebula in one direction or by a spiral motion. It is certain, however, that the motion is not radial.

The amount of motion is almost incredible, being no less than at the rate of 11′ per year. The greatest displacement (proper motion) in the stellar universe, so far observed, is less than 9″ per annum.

Such an exceptional velocity as is here indicated leaves little doubt of the intimate connection of this nebulous matter with the Nova and its outburst.

It is perhaps too soon to say just what bearing the foregoing observations will have upon the explanation of the phenomena connected with new stars. It would seem, however, that such great velocities pointed rather to a violent collision of some sort than to an outburst within a dark and comparatively cool body; but whether a collision of a solid body with another, or the passage of a solid body through a gaseous nebula or a swarm of meteorites is uncertain.

It may be that in the outburst of Nova Persei we have seen the formation of a nebula, either planetary or spiral.

Professor Wolf's photographs were obtained on August 23d, and a comparison with his nebula would be valuable; but neither reproductions of his photographs nor the accurate coördinates of the nebula have been published.

Mr. Joel Stebbins, Fellow in Astronomy, assisted in taking the photograph with the Crossley reflector.—Lick Observatory, University of California, *Bulletin No. 10*, November 10, 1901.

THE SOURCES OF STANDARD TIME IN THE UNITED STATES.

R. G. AITKEN.

For Popular Astronomy.

A friend recently called my attention to a little note on Standard Time published in an eastern weekly and queried "where does Lick Observatory come in?" The first two paragraphs of the article in question read:

"'What time is it?' Few questions are more common than this, and yet each day the United States government goes to a great expense in giving it an official answer. To ascertain the instant when it is noon on the seventy-fifth meridian, and to send the information all over the country, is a great and a costly task. The Astronomical Observatory in Washington computes the true time, which is thence transmittted by electricity to every important city and town.

About five minutes before the Washington noon the telegraph companies cut off all their regular business, except on lines where they have more than one wire. Then they connect all important points, from which there may be numberless ramifications, with an electric wire going into the great clock in the Observatory, so that all over the country its tickings may be heard. For the ten seconds just before twelve o'clock there is silence, which is broken by the 'noon beat.' Regular business is then resumed."

This is interesting but it is not entirely accurate. The tickings of the "great clock in the Observatory" in Washington are not heard "all over the country." They do not reach any part of that large section of it known as the Pacific slope.

Having noticed several statements in newspapers and journals to the same effect as the one just quoted, I set myself to find out as fully as possible, all the sources of accurate time in this country. The result of my inquiries will, I think, be of interest to the readers of Popular Astronomy.

I made no attempt to ascertain at how many places in the United States time is determined from observations of the stars or Sun. It may be assumed that every astronomical Observa-

PLATE IV.

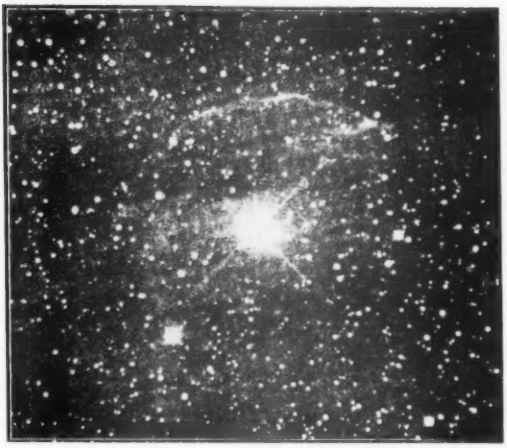


FIG. 1.—NEBULOSITY ABOUT NOVA PERSEI.
Photographed by G. W. Ritchey with Two-Foot Reflector, Sept. 20, 1901.

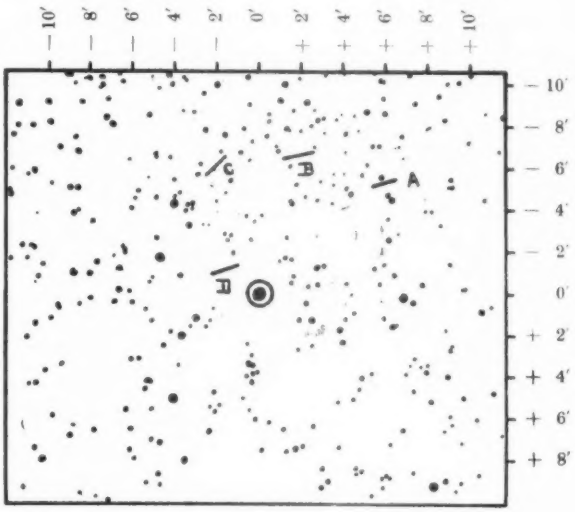


FIG. 2.—DIAGRAM SHOWING MOTION OF NEBULAR CONDENSATIONS ABOUT NOVA PERSEI FROM SEPT. 20 TO NOV. 7.

tory that includes a transit instrument in its equipment takes time observations regularly; and probably a great many persons not connected with any Observatory take such observations for their own interest. But the sources of time for the public generally, are not so numerous as I had supposed. They are, in fact, very few. The clocks of the Naval Observatory at Washington furnish the time for the great majority of the people living east of Ogden, Utah, and El Paso, Texas. West of these points, the people, whether they know it or not, depend mainly upon the clocks at the little Observatory in the navy yard at Mare Island, California.

At present, only three other observatories, the Allegheny, the Goodsell, and the Lick, distribute time signals over any considerable territory. The Pennsylvania lines (the term applied to that part of the Pennsylvania System of Railroads east of Pittsburg) recieve their time from the Allegheny Observatory, which sends out continuous signals through the twenty-four hours of each day. This System covers the entire state of Pennsylvania and also eastern New York. The Goodsell Observatory sends two time signals daily to the Great Northern, the Northern Pacific, the Great Western and the "Soo" lines, amounting in all to about 13,000 miles. The noon signal from the Lick Observatory reaches all points on the Southern Pacific System as far east as Ogden and El Paso.

Time signals from Washington or Mare Island are also sent to all important centers in these regions over the wires of the Western Union Telegraph Company.

Several other observatories furnish time on request to local street railroads and private parties; and the Harvard College Observatory sends out continuous signals to the fire alarm headquarters of the city of Cambridge, where they are used for giving bell and whistle signals on the fire alarm system at noon and at 9:30 P. M. A number of observatories that formerly furnished the time to the railroad companies in their vicinity, have, in recent years, been obliged to abandon the service. The Western Union Telegraph Company receiving signals from Washington free, can supply the time to the railroads at less expense.

One of my correspondents on this subject informs me that he tested the accuracy of the Western Union time service through a period of some months, a few years ago, and found frequent diferences of five seconds and some of ten seconds and over; due, he supposes, to the carelessness of the telegraph company.

In conclusion I give an extract from a letter received from the

Chief of the Bureau of Equipment, Navy Department, Washington, which will be of general interest:

".....You are correct in the belief that the only two sources where Government time is furnished are the Naval Observatory, Washington, D. C. and the Observatory at the Navy yard, Mare Island, California. But in addition to these the Bureau has established, at various points, time-ball systems at the Branch Hydrographic offices for the purpose of assisting masters of vessels, as well as men-of-war, in regulating their chronometers.

"Whenever vessels reach the waters of one of these stations, the comparison of chronometers is made either from the dropping of the time-ball at a given time or by the master's taking their chronometers to the branch office, where a direct comparison can be made. Masters of vessels the world over, trading with our ports, have expressed their highest appreciation of this aid rendered them, and the Bureau has in contemplation, as circumstances will permit, an extension of this time system to other points than those enumerated below.

"There are at present established time-ball systems at Philadelphia, Pa.; Norfolk, Va.; Newport News, Va.; New Orleans, La.; San Francisco, Cal.; Sault Saint Marie, on the northern lakes; Chicago, Ill.; Cleveland, Ohio; and Buffalo, N. Y. Within six weeks it is believed new systems will be established at Duluth, Minn., and Galveston, Texas. It is the intention to establish during the calendar year an additional system at Boston, Mass., should the appropriations permit.

"It may be stated that these systems give the time of local noon not only to the shipping but also to the public as well. They are all supplied through the Western Union Telegraph System from Washington, except San Francisco, which is supplied from Mare Island."

LICK OBSERVATORY, University of California,
November 20, 1901.

AN ASTRONOMER FOR THE HEAD OF THE UNITED STATES NAVAL OBSERVATORY.

W. W. PAYNE.

In the November number of this publication, we printed the report of the Board of Visitors to the Naval Observatory, as it appeared in the *Washington Post*, of Nov. 12, 1901. That report went into the condition of things at the United States Naval

Observatory very thoroughly, very fairly and very definitely. The Board of Visitors took high ground, and dealt with the essentials of the problem submitted to them, and made recommendations for very radical changes in the management of the Naval Observatory. The report containing these recommendations was made to Hon. John D. Long, Secretary of the Navy last month, and it embodies well the views of leading astronomers in this country outside of and some at Washington for the last twenty years. The line officers in the Navy would naturally oppose such changes as those now proposed, because it takes from them the opportunity of enjoying the distinction of a high-ranking scientific position of a civil kind which they are in no wise qualified for simply because they may have gained a certain rank, as a line officer in the Navy. In some cases, in recent years, this has been so absurdly and conspicuously the fact, that scholars in scientific circles outside of Washington have spoken out very vehemently against the management of the Naval Observatory, and have tried to bring some needed changes in the organization and the administration of the Observatory. But the influence of the men in the Navy at Washington, in the past has been so great and so persistent that it has overcome all attempts at reform up to this present time.

We now have indications that something will be done in the right direction; for evidently the ear of the Secretary of the Navy has been reached, and that scholarly, intelligent, and able officer will do—has largely done already—his whole duty. We have good reason to expect still further that Secretary Long will complete, so far as he is concerned, the work so well begun.

We publish with pleasure that part of his report which appeared in the *Washington Post* Nov. 16, 1901, relating to the United States Naval Observatory:

"In his annual report to the President, Hon. John D. Long, Secretary of the Navy, indorses the recommendation of the Board of Visitors to the Naval Observatory, that a civilian astronomer be placed at the head of that institution. His indorsement of the board's recommendation is unqualified and absolute, and he urges in strong language the necessity of action. In his report Mr. Long says:

"Attention is called to the first and very important report of the Board of Visitors to the Naval Observatory. I earnestly commend its recommendations to careful consideration. This board was created by act of Congress in March last. I believe its visitations will be found valuable in making the Observatory

efficient and in rank with the best institutions of the land. It appears that no other Observatory in the world has the expenditure of so much money, but also that its results are not commensurate with those of some other Observatories the expenditures of which are less. Its head should of course be the best astronomer, who has proper administrative qualifications, that can be found in the country. It is especially desirable that he should have continuity of tenure, and the Observatory has undoubtedly suffered from frequent changes in its superintendents.

"While the average term of service of superintendents at Greenwich has been twenty-eight years and at Harvard fifteen, at the Naval Observatory it has been only a little over three. I urgently recommend that the legislation of the last Congress to the effect that the superintendent of the Naval Observatory shall be, until further legislation by Congress, a line officer of the navy of a rank not below that of captain, be repealed, and that on the contrary, it be enacted that there shall be no limitation upon the field from which the superintendent is to be selected. As well might the above-quoted statute have provided that the Commissioner of Fish and Fisheries should be selected from the line of the Marine Corps, or the Director of the Geological Survey from the line of the army.

"There is no vital relation between the navy and the Observatory. It may happen that some naval officer is pre-eminently qualified for such a place, in which case he would be appointed to it, but the country is entitled to have unlimited range of selection. The present limitation, which shuts out the whole body of civilian astronomers and even any astronomer in the navy who does not happen to be in the line, or, if in the line, below the rank of captain, is peculiar. Only a very small proportion of naval officers are not below the rank of captain, and as most of them are required for naval services—a requirement which is now increasing—the list from which selection can be made, is a noticeably small one. It is evident, too, from the wording of the above quotation from the statute, that Congress in passing it had in mind further legislation in this respect."

THE LEONIDS. GRAND DISPLAY OF METEORS IN SOUTHERN CALIFORNIA.

EDGAR L. LARKIN.

FOR POPULAR ASTRONOMY.

The regular shower of Leonid meteors was seen at this Obser-

vatory from midnight until dawn on Nov. 15, 1901. It was most impressive here in the silence and profound solitude of the mountains. The first meteor was observed at $11^h\ 55^m$ P. M. Nov. 14 and to midnight 4 were noted. But the radiant in the Sickle of Leo had not yet appeared over the peaks.

TABLES OF TIMES AND METEORS.

Times—From		To			No. of Meteors.
P. M. 14th.					
h	m	h	m		
11	55	00	00		4
A. M. 15th.					
00	00	1			32
1		1	54		27
1	54	2	43	Cloud; straggling not counted. 59m omitted	
2	43	3			19
3		4			173
4		5			297
5		5	40		109
286 minutes,					Total 661 = 2.31 meteors per minute or 657 on the 15th.

East of the Observatory at a distance of 1,800 feet there extends a range of peaks from north to south, whose heights above the building vary from 80 feet in the S. E. to 1,340 feet in the N. E., the altitude of the Observatory being 3,420 feet. Therefore the radiant within the Sickle of Leo did not appear until some time after its true rising above rational horizon. When it finally came up by the side of a peak at $00^h\ 40^m$, the meteors were coming at a rate of 1 per minute, which rate steadily increased until $4^h\ 20^m$ A. M., 15th. Possibly a little less than half presented streamers from 2° to 15° in length. Four-fifths, at least, were white, a few greenish-blue, a dozen or so tinged with red, 2 being red. Those leaving trails had high speed, the small meteors not being visible more than half a second. Here are directions of a few of the most prominent, all in this list leaving brilliant streams of incandescent dust.

Number of Meteors.	Direction of Flight	
	From	Toward.
17	ε Hydræ	*a* Columbæ
20	Praesepe	ε Hydrae
21	ε Hydrae	30 Monocerotis
24	Praesepe	Gamma Leonis
25	"	Procyon
28	Regulus	Ursa Majoris
30	ε Hydrae	Regulus
32	Procyon	Sirius
34	Castor	Betelguese
43	Sirius	Ocean
44	Regulus	Naos
51	Procyon	Sirius
55	30 Mon.	Canopus
57	"	Naos

Number of Meteors.	Direction of Flight	
	From	Toward.
61	Denebola	Ursa Majoris
81	Praesepe	Procyon
83	Rigel	West
86	ε Hydrae	Denebola
92	Denebola	Canopus
109	Betelguese	West
115	Rigel	Ocean
126	Sirius	Canopus
142	Naos	Ocean
149	"	Canopus
168	30 Monocerotis	Rigel
174—5	Gamma Leonis	Denebola
197	Regulus	"
	(Too numerous to make record)	
590—600	Vanished behind eastern peaks, Leo being at high altitude.	
	4 A. M.	
603—6	Leo	Arcturus
607—9	Arcturus	Behind eastern peaks
579—80	Zenith	Arcturus
582	Zenith	Polaris
583	Spica	Peaks
594—7	Leo	Ursa Majoris
621	Leo	Spica
624—5, 6, 7	Leo	Mercury

No. 229 was remarkable. It shot with terrific speed from near the Sickle to a point π Orionis between Betelguese and Aldebaran leaving a streamer 15° long and 35′ wide, greenish-blue and white. Nucleus dissipated into cosmic debris at π Orionis, leaving streamer intact for several minutes. This bent in the middle almost at a right angle and assumed the shape of the letter F, growing wider to fully 1° wide. In about 10^m, the top of the F became detached and floated slowly to Aldebaran, where it vanished. The upright grew wider and fainter until it too disappeared at π Orionis after the expiration of 14 minutes. No. 521 went with high speed and brilliant streamer from the east to the shoulder of Ursa Majoris. The fire-ball disintegrated, the trail 10° long expanded to 30′, bent into the form of the Greek letter Omega and remained 6^m. These were the only meteors having persistent light. At $1^h\ 54^m$ a mountain cloud suddenly condensed before Leo and remained 59^m until $2^h\ 53^m$. While this obscuration was on, meteors could be seen straying about the edges, but these were imperfect and not counted. The cloud dissolved suddenly at $2^h\ 53^m$, the sky remaining clear until the solar glow put out the light of the pyrotechnics at $5^h\ 40^m$ A. M. 15th. The same shower was magnificent at Niagara, Nov. 13, 1833, and the splendors of the scene have been recounted in the literature of the world. But, it could not have been more awe-inspiring than here in the impressive, silent and solitary mountain summit. The supreme silence itself is over-powering to

sense, but when shot and shell are flying on all sides with appalling speed, some seemingly aimed at peaks, others at the sea, and others, when the radiant was high up, hurled toward the yawning cañons low under either side of the Observatory, and still others straight toward the myriad electric lights of Los Angeles, the scene rivalled Niagara or any other on Earth. The highest number seen at once was 6, at 4^m 9^h. The most rapid fall was from 4^h to 4^h 20^m—5 per minute. One large one occulted Mercury, and another came close to Canopus. Some seemed to be near the Earth and others at great heights. A few looked as though they fell in the city, distant 14 miles, and others into the ocean, 28 miles. This, of course was due to perspective. The times here given are Pacific or 120° time. The longitude of the Observatory is 7^h 52^m $29^s.487$ and latitude 34° 17′ 44″.5.

ESTIMATES OF BRIGHTNESS.

25	meteors	Equal in brightness to Venus.
12	"	Five times brighter than Venus.
3	"	Ten " " " "
2	"	Twenty times brighter than Venus.
40	"	Bright as Jupiter at maximum.
20	"	Bright as Sirius.
120	"	Bright as Rigel.

The meteors were numbered in writing at instant of appearance to prevent error. Just before the rising of the radiant the mirror of the heliostat was set on the rising point, and spectroscope arranged to secure a spectrum if possible. None was obtained. Throughout the display, not one emerged exactly from the radiant, "head on."

The shower was seen and large numbers of meteors counted in Los Angeles. No sound was heard, not even when 229 and 551 came to an end in brilliant flashes. The general trend was from Leo toward S. W., a small number only going to the north. Perhaps one-fourth the total was counted and recorded.

MOUNT LOWE OBSERVATORY,
ECHO MOUNTAIN, California, Nov. 18, '01.

ECLIPSE AID TO CHRONOLOGY.

REV. Q. A. WHEAT.

FOR POPULAR ASTRONOMY.

The help of astronomical calculations has been found to be of incalculable value to this writer in his examination of Biblical history, and in determining reasonably to his satisfaction the disputed dates of certain events.

The theory of research and the process by which my first re-

sults were reached would be irrelevant if stated here; however, about two years ago I was led to the conclusion that the Jewish captivity occurred about the year B. C. 540, some years later than common chronology dated that event. Placing in parallel columns known contemporaneous events, recorded in the histories of Judea, Babylon, Medea, Lydia, Tyre and Persia, given by the Holy Bible, Herodotus and Josephus were found to be contemporaneous the early part of the reign of Nebuchadnezzar (Labynetus I) king of Babylon; the latter part of the reign of Cyaxares, of Medea; and the first half of the reign of Alyattes, of Lydia. This suggested a suspicion that the noted war of six years between the Medes and Lydians happened about the time Nebuchadnezzar's thirteen years siege of Tyre, placing him convenient to Syennesis, of Cilicia, for the arbitration of the peace as recorded by Herodotus, and if so, the famous "eclipse of Thales" certainly took place about the year B. C. 550; although I understood the solar eclipse of B. C. 610 to have been generally adopted as that eclipse. Apparently I was unfortunate in an utter ignorance of eclipse calculation, but a random letter in search of help was very kindly answered by Mr. C. L. Doolittle, director of Flower Observatory, Pennsylvania, referring me to my very dear friend, Professor J. N. Stockwell, of Cleveland, Ohio, whose kind, prompt, patient, intelligent and laborious assistance has proven to me that my ignorance has brought bliss, by his acquaintance.

My request of Professor Stockwell for datum of a possible eclipse about the year B. C. 550, total at Sardis, the then capital of invaded Lydia, promptly secured his map of eclipses about that period, and the total eclipse B. C. 547, October 23, local time Sardis 1:43 P. M. in less than fifteen minutes examination satisfied me that it was the eclipse wanted; every condition of the record being met without any "fitting."

Subsequently, Professor Stockwell suggested to me the possibility that a total eclipse of the Sun would explain the darkness —"an horror of a great darkness fell upon Abram"—mentioned in Genesis 15 : 12. This evidently was a test case of his astronomical theory, and my chronological theory, and my reply was substantially, "If my theory be true, and your suggestion be correct, you should find a total eclipse of the Sun over Palestine about the year B. C. 1924; and after an unavoidable delay of two or three weeks he reported a congratulatory answer—"Total eclipse of the Sun, B. C. 1927, July 13, local time Palestine 2:43 P. M."

I also asked for a possible eclipse of the Sun about B. C. 664, "late in the afternoon and the Sun re-appearing before sunset at Jerusalem and his answer was "Total eclipse of the Sun B. C. 661, June 27, local time 4:43 P. M.," and I thus determined the fourteenth year of Hezekiah to have been B. C. 661; and the time of the visit of Isaiah the prophet, to Hezekiah the sick king to have been coincidental with the solar interference by eclipse, June 27, 4:43 in the afternoon. The miracle of the Divine will was none the less here, than in the healing of the king by the fig applied to the boil.

The next dates to determine were the year of the Jubilee proclamation by Zedekiah, king of Judah, referred to by Jeremiah, in chapter 34; and the year of the "Exodus." The one found readily determining the other, for they were the extremes of a given interval.

Sufficient data in details having been found to show 19 jubilee years, equal 931 common years, between the time of the proclamation, and the year of the Exodus and only one sabbatic year, of seven common years in which to locate the year of the proclamation, was now the issue.

By this time I had become an enthusiastic follower of my friend Stockwell, and not finding a nail in Zedekiah's reign by which to fasten the jubilee end of my line, I examined more closely than hitherto the circumstance connected with the Exodus year. The "darkness over all the land of Egypt," the last "plague," or terror, to the Egyptians, several days before the night of death to the Egyptians, and release to the Hebrews, was a solar interference that may be accounted for by an eclipse! But the darkness was for three days, says the text. As it stands with the punctuation of subsequent centuries, yes! But that punctuation removed, or changed, which may be done without sacrilege, the text would stand, "and darkness was over all the land of Egypt;" and for three days the horror, or terror, resulting from it, caused that none of the Egyptians moved out of their houses during that time.

Adopting this interpretation of the event, Professor Stockwell was requested to find a possible eclipse, locality Egypt B. C. 1478—a failure for locality this time.

Another trial, at the other extreme of my limit, gave an eclipse of the Sun B. C. 1472, July 23, central time, island Minorca, and city Warsaw; southern limit made the eclipse too small in Egypt to meet the requirements of the case.

One more trial, of which I wrote to my patient friend. "If a failure I must abandon the point."

For reasons on purely chronological suggestion of changes necessitating the reform of the calendar by Julius Cæsar, supported by the evident season of the year in which occurred the several incidents immediately preceding the Exodus, the Exodus was thought to have taken place early in April, and I asked the finding of an eclipse 3rd to 8th of April B. C. 1475, and I was startled almost into an ecstasy when his answer came, "Annular eclipse of the Sun over all Egypt B. C. 1475, March 30, local time northern Egypt 4:30 P. M., about 10 digits covered; line of southern limit near mouth of river Congo and Cape Guardafui on the extreme east coast of Africa."

My own experience has been that without astronomical help I was "beating up and down in this Adria," with this help I am happily able to offer to the reader's consideration the following chronological conclusions extracted from charts that I have compiled:

Deluge	B. C. 2357
Deluge to Exodus, 882 common years	B. C. 1475
Exodus to Zedekiah's Proclamation, 931	B. C. 544
Proclamation to Captivity, 3 years	B. C. 541
Captivity to birth of Jesus Christ, 537 years	B. C. 4

The year of Zedekiah's "Jubilee" is the key to Biblical chronology previous to the captivity.

The years given below were "Jubilee" years, namely:

B. C. 2356, Noah abandoned the ark.
B. C. 1474, Tabernacle set up, and "Law" promulgated.
B. C. 543, Two years before the "Captivity."
B. C. 4, Nativity of Jesus Christ.

Before concluding this paper, may I call attention to the following named facts:

The eclipse of B. C. 763, local time Nineveh 2:00 P. M., has been adopted as the eclipse recorded to have occurred in the ninth year of Assur-danin-il. The interval to Nebuchadnezzar's first year, according to the tables is 171 years detailed as follows, namely: (Babylonian succession.) Assur-danin-il, remainder of reign, 9 years; Assur-likh-khus, 8 years; Tig-lath-pilesir II. 20 years; Nabonassar, 14 years; Nadios 2, years; Khiziros and Porus, 5 years; Iluæus, 5 years; Merodach-baladin, 12 years; Sargon, 5 years; Belibas, 3 years; Assur-nadios, 6 years; Regebelos, 1 year; Mesesi-mordakos, 4 years; Interregnum [civil war on assasination of Sennecharib?] 8 years; Esar-haddon, 13 years; Assur-banipal, 35 years; Naboplassar, father of Nebu-

chadnezzar, 21 years = Nebuchadnezzar's first year, B. C. 592; and Nabopolassar's first year would have been B. C. 613; so then if Nabopolassar was Labynetus I, the father of the king of the same name (Labynetus) against whom Cyrus made war, the contention for eclipse B. C. 603, versus 610 B. C. for Thalesian honors is well matched, but would Cyrus have been present at the release of the Jews, 70 years after the captivity began in Nebuchadnezzar's 18th year? Figures are against it, for Nebuchadnezzar died in the 25th year of the captivity, and if Cyrus had have taken Babylon in that year his whole reign of 29 years would have fallen short of the year of release of the Jews 16 years.

With the above showing both claims, 610 and 603 fail, and none other within a space of fifty years either the claims for eclipse of 763 also fail, or there was no eclipse to the credit of Thales as stated.

The fact is my charts revealed an error in Shabmanezer's place in contemporiety.

An enquiry of Professor Stockwell respecting a probable eclipse at Nineveh later in that century, not necessarily total but positively observable by the unaided eye; for a total eclipse might pass without record by one man, and a comparatively small eclipse be put to record by another man. He reported two large eclipses, one B. C. 730 March 14, and another B. C. 723 April 25, and I immediately placed B. C. 730 March 14, in correspondence with Assur-danin-il's 9th year, satisfactorily with other parts of the chart. and after the lapse of some months accidentally it was manifested that 730-547 = 183 years to eclipse B. C. 547 Oct. 23. And 183-171 (the interval between Assur-danin-il's 9th and Nebuchadnezzar's 1st year) = 12 years, into the reign of Nebuchadnezzar, or 5 years after he began the siege of Tyre. So then, as these eclipses are rigid writers of time to the second, to me it is evident that B. C. 547 Oct. 23 is the celebrated "eclipse of Thales," and that the difficulty has been our misapprehension.

PORT REPUBLIC, Va., Nov. 20, 1901.

AN ASTEROID ORBIT OF GREAT ECCENTRICITY.

EDWARD C. PICKERING.

From an examination of a plate taken on August 14, 1901, with the Bruce telescope, Dr. Stewart found an asteroid having

the great southern declination, — 62°. As no known asteroid was so far south at that time, a series of photographs was taken, from which, and from one previous photograph, the approximate positions given in Table I have been derived.

TABLE I.

OBSERVED POSITIONS.

Date. 1901.	G. M. T. h m	R. A. 1900. h m	Decl. 1900. ° ′
Aug. 5	16 10	19 33.7	— 62 36.1
" 14	15 12	19 27.4	— 61 30.0
" 15	16 15	19 27.2	— 61 20.2
" 17	14 25	19 27 1	— 61 0.5
" 20	14 33	19 27.25	— 60 26.7
" 23	14 47	19 28.2	— 59 48.5
Sept. 2	12 54	19 35.1	— 57 17.5
" 11	16 13	19 46.3	— 54 29.4
" 18	13 59	19 57.1	— 52 6.7
" 30	12 54	20 19.2	— 47 34.0
" 30	13 46	20 19.25	— 47 33.2
Oct. 1	14 41	20 21.3	— 47 8.1
" 2	15 09	20 23.4	— 46 43.7
Nov. 13	12 43	21 52.5	— 28 14

A circular orbit was first computed by Miss Anna Winlock. This gave the surprising result that the heliocentric diurnal motion exceeded 2200″, corresponding to a distance from the Sun less than that of any known asteroid. As Professor Newcomb was spending a few days in Boston, he courteously undertook, with the assistance of Miss Winlock, to determine elliptical elements for this object. The results are given below:

ELEMENTS.

Epoch 1901, October 2.627, G. M. T.

$M = 358°\ 30'$		$\phi = 22°\ 8'$
$\omega = 301\ 19$	1900.0	$\mu = 860''$
$\Omega = 35\ 48$		$\log a = 0.4103$
$i = 18\ 38$		Period = $4^y.13$

The uncertainty of the elements, ω and Ω, may be estimated at $\pm$ 1°.

From these elements it appears that the great peculiarity of this orbit is the ellipticity, which exceeds that of any known asteroid. The only other asteroids for which ϕ exceeds 20°, are Eva (164) for which it is 20° 19′, and Istria (183) for which it is 20° 27′.

At the time of discovery the asteroid was near perihelion, and therefore was moving very rapidly around the Sun, at a distance of about 1.6. An approximate ephemeris for Greenwich Midnight is given in Table II, which shows that the asteroid is moving rapidly north, and is now within reach of the telescopes in Europe and the United States.

TABLE II.

APPROXIMATE EPHEMERIS.

J. D.	Date. 1901-02.	R. A. 1900.0	Decl. 1900.0	log r	log Δ
		h m	° ′		
5560	June 24.5	20 8.1	−56 33	0.2598	9.9613
5580	July 14.5	19 54.4	−61 28	0.2434	9.9273
5600	Aug. 3.5	19 31.6	−62 41	0.2288	9.9208
5620	" 23.5	19 26.2	−59 52	0.2171	9.9360
5640	Sept. 12.5	19 46.2	−54 14	0.2090	9.9660
5660	Oct. 2.5	20 22.1	−46 49	0.2052	0.0064
5680	" 22.5	21 4.2	−38 16	0.2060	0.0549
5700	Nov. 11.5	21 47.5	−29 14	0.2114	0.1095
5720	Dec. 1.5	22 30.0	−20 15	0.2209	0.1674
5740	" 21.5	23 11.3	−11 42	0.2338	0.2258
5760	Jan. 10.5	23 51.8	− 3 47	0.2491	0.2819
5780	" 30.5	0 31.9	+ 3 26	0.2661	0.3339

The position for November 13, given above, was obtained by cablegram from Arequipa, and indicates that the errors of the ephemeris on that date, in right ascension and declination, are $-0^m.7$ and $-4'$, respectively.

HARVARD COLLEGE OBSERVATORY,
Circular No. 63, November 19, 1901.

THE PERIOD OF ALGOL.

W. W. PAYNE.

A short article of especial interest to observers of variable stars appeared in *The Astronomical Journal*, No. 511, p. 60, by S. C. Chandler in which he makes a comparison of the observations of Argelander, Schmidt and Schönfeld. These three skilled observers gave careful attention to the observations of the variable star Algol long enough to make a series for each independent of the others, so that the series by each observer might be considered separately, or they could be studied together as some of the observations of each overlap those of the others. All but the first paragraph of Mr. Chandler's article is given below in the author's own words:

"On p. 161 of Vol. VII, *A. J.*, I have given a table of yearly mean epoch epoees deduced separately for the different observers. By combining these into normals, each embracing one or two year's observations, and taking differences for epochs separated by several hundred periods, independently for Argelander, Schmidt and Schönfeld, we have the appended table. The column *O* contains the observed periods, and column *C* the periods computed from the elements in *A. J.*, 509.

"The differences *O—C* display very clearly a systematic devia-

tion from the elements that must be entirely independent of systematic personal differences in deducing the times of minima, as has been stated above. The accordance of the three sets of observations in this regard enables us to conclude with rersonable certainty that there was an actual irregularity, consisting of a rather sudden diminution of the period, with respect to the elements, between 1854 and 1857 of about 1″-5, and a subsequent increase, gradual from 1863 to 1872, of the same amount.

"Thus we have additional evidence, of a cumulative character, of the reality of such minor irregularities, similar to that adduced in *A. J.* 509 from a comparison of Müller's results with those of other observers for the interval 1875 to 1878:

Period $2^d\ 20^h\ 48^m$ +

Date	Epoch	*O*	*C*	*O*—*C*	Wt.	Observer
		s	s	s	s	
1844.4	5661	53.9	53.9	+ 0.0	3	Argelander
1847.4	6042	53.2	53.0	+ 0.2	2½	"
1850.1	6380	53.3	52.8	+ 0.5	1½	"
1851.4	6548	53.2	52.7	+ 0.5	3	"
1851.7	6583	53.3	52.6	+ 0.5	1½	Schmidt
1854.0	6880	53.2	52.8	+ 0.4	1	Argeland
1854.1	6894	53.0	52.8	+ 0.2	3½	Schmidt
1856.0	7135	54.1	53,1	+ 1.0	2	Argelander
1856.6	7212	52.6	53.1	— 0.5	2	Schönfeld
1856.8	7233	53.3	53.2	+ 0.1	3½	Schmidt
1857.4	7299	52.2	53.3	— 1.1	1	Argelander
1859.2	7534	52.6	53.5	— 0.9	2	Schönfeld
1859.4	7556	52.5	53.6	— 1.1	1	Argelander
1859.5	7586	53.0	53.6	— 0.6	1½	Schmidt
1862.1	7913	52.8	53.9	— 1.1	1	Argelander
1862.3	7933	53.6	53.9	— 0.3	4½	Schmidt
1862.9	8023	54.2	53.9	+ 0.3	3½	Schönfeld
1864.5	8218	54.1	54.0	+ 0.1	2½	"
1864.6	8229	53.8	54.0	— 0.2	6	Schmidt
1867.4	8580	53.9	53.8	+ 0.1	4	"
1867.8	8635	54.0	53.6	+ 0.4	4	Schönfeld
1869.4	8836	53.9	54.0	— 0.1	2½	"
1869.9	8902	53.6	53.3	+ 0.3	4	Schmidt
1871.4	9081	53.8	53.0	+ 0.8	2½	Schönfeld
1872.6	9243	52.9	52.6	+ 0.3	5	Schmidt
1872.8	9278	53.4	52.6	+ 0.8	2½	Schönfeld

SUPPLEMENTARY REPORT ON NON-EUCLIDEAN GEOMETRY.

GEORGE BRUCE HALSTED.

CONTINUED FROM PAGE 558.

One of these, just being issued by G. Carré et C. Naud, 3 rue Racine, Paris, is 'La géométrie non Euclidienne' by P. Barbarin, professor at Bordeaux, a place made sacred for non-Euclideans by the memory of Hoüel. How great and practical is the inter-

est of this book can be gathered from the headings of its chapters.

I. 'General and historical considerations.' How the non-Euclidean doctrine was born and gradually developed.

II. 'Euclid's definitions and postulates.' Study of the rôle that they play in the principles of geometry.

Simple and elementary expose of the three geometries after the method of Saccheri.

III. 'Distance as fundamental notion.' The definitions of the straight and the plane according to Cauchy. The works of Mr. de Tilly.

IV. 'General geometry in the plane and in space.' Resume of the principal general propositions.

V. 'Trigonometry.' Elementary demonstration, after Gerord and Mansion, of the formulas for triangles and quadrilaterals.

VI. 'Measurement of areas and volumes.

VII. 'The contradictors of the non-Euclidean geometry.' The principal objections made against the non-Euclidean geometry. Answers to be made thereto.

VIII. 'Physical geometry.' How we might attempt to find out if the physical world is not Euclidean; how angles and distances could be measured with a much greater approximation, for example, angles with an error much less than 1/100 of a second.

A brief article by Professor Barbarin, 'On the utility of studying non-Euclidean geometry,' which appears in May (1901) number of Professor Cristoforo Alasia's new Italian journal *Le Matematiche*, shows that Hoüel had reached the weighty insight which we have quoted from Study, namely, that knowledge of non-Euclidean geometry is essential for any mastery of Euclidean geometry.

Says Barbarin:

"I. The question of the source of the theory of parallels has been one of the most interesting scientific preoccupations of the century; it has made to flow torrents of books, and given theme to remarkable works. Thanks to the theorems of Legendre, to the discoveries of the two Bolyai, of Lobachevski and of Riemann, thanks to the original researches of Beltrami, and of Sophus Lie, of Poincare, Flye Ste. Marie, Klein, De Tilly, etc., we cannot any more be mistaken as to the true scope of the celebrated proposition which bears the name of Postulate of Euclid.

"1°. This is not in any way contained in the classic definitions of the straight and the plane.

"2°. This is, among three hypotheses equally admissible, and which cannot all be rejected, only the most simple.

"Is it perhaps chance alone which gave to the great Greek geometer the choice of his system of geometry? or did he perceive, at least in part, the difficulties and the greater theoretic complication of the other two? We will never know with certainty.

"But in the presence of his work, so perfect and so rigorous, one thing, however, appears not to be doubtful: the place which he assigned to his proposition, the enunciation which he gave of it, attest that this proposition had to his eyes only the value of an hypothesis; otherwise he would have formulated it in other terms and would have attempted to demonstrate it.

"The ideas of Lobachevski and of Riemann were diffused only very slowly. They were so, above all, thanks to the translations of Hoüel.

"This scientist, whose activity and power of work were prodigious, could not resist the desire to master all the European languages, with the aim of being able to read in their original text, and then make known to his contemporaries the most celebrated mathematical works.

"He admired Lobachevski, whom he surnamed the *modern Euclid*, and in his course professed at the scientific faculty of Bordeaux, he did not let pass any occasion to put him in evidence.

"II. Hoüel was persuaded that the knowledge of the non-Euclidean geometry is indispensable for thoroughly mastering the mechanism of the Euclidean geometry.

"Despite its paradoxical form, this idea is most just.

"General geometry or *metageometry* contains in fact a great number of propositions common to all the systems, and which ought to be enunciated in the same terms in each of these. If the general proposition can be demonstrated in terms general for these, such should be preferred, even if, to attain this, it be necessary to subject the ordinary form to some modification. To cite only one example, we take the convex quadrilateral inscribed in a circle.

"In Euclidean geometry, *the sum of two opposite angles is constant and equal to two right angles*; in non-Euclidean geometry *this sum is variable*. Notwithstanding this, the two forms may be reconciled, since in both cases *the sum of two opposite angles equals that of the other two*, and this is sufficient for a convex quadrilateral to be inscriptible.

"Confronting the proposition with that which concerns the

circumscribed quadrilateral, we put in full light a correlation which, *à priori*, ought evidently to exist.

"This correlation, which is the very heart of general geometry, and which does not always appear in the ordinary geometry with the same clearness, can be utilized for finding new properties of the figures.

"*Example: Every conic is the locus of the points such that the sum of the tangents from these drawn to two circles is constant:* every conic then will also be *the curve envelope of the straights which cut two given circles under angles of which the sum is constant.* (Excellent problem for investigating directly).

III. Is it expedient to associate the non-Euclidean geometry with instruction, and in what measure?

"If we treat of higher instruction, with ardor we respond affirmatively.

"In the courses of higher geometry of the universities the names of Bolyai, Lobachevski, Riemann have their assigned place, and there are still divers unexplored domains on the road which these scientists have opened.

"In so far as it refers to secondary instruction, the question is more delicate. The programmes of preparatory courses at the high schools contain all, or almost all, special mathematics and spherical geometry.

"It would not be then a great inconvenience to make opportunely a discrete allusion to general geometry: on the contrary, the attention of the students and their critical spirit would be held awake by the necessity of investigating if such proposition which is expounded to them is of order particular or general.

"At least two indispensable conditions should be satisfied; it is requisite:

"1°. *That in all books put in the hands of the student, the hypothetical and wholly fractious character of the Euclidean postulate be put well into relief.*

"In my classes I have recourse with success to the simple procedure which follows, and which I recommend. Take the straight *AB* and the two equal perpendiculars *AB*, *BD*: the angles *ACD*, *BDC* are equal, and may be right, acute or obtuse. But whichever be the one among these three hypotheses which we assume for this particular quadrilateral, we must conserve it for *all* the other like quadrilaterals. We choose the system of geometry in which these are right angles, and which corresponds to the Euclidean hypothesis.

"2°. That the invertibility of the postulate of Euclid be com-

pletely given up in all the demonstrations in which it can be done without and where nevertheless it is wrongly used.

"See, for example, the theorem on the face angles of a trihedral or polyhedral angle.

"We should recognize that great advances have been made in these latter years in the sense indicated.

"If the ideas of general geometry tend to become popularized, the honor of it is due above all to the periodicals which have given their hospitality, and in special manner to *Mathesis*, so ably edited by our excellent confrère, P. Mansion of Ghent.

"In the course of the last eight or ten years this journal has published numerous articles on Metageometry, written with as much competence as good sense. We counsel their perusal;"

It will be seen from our quotation, that Professor Barbarin bases his exposition on the method of Saccheri as the simplest.

The same is true in the other new text-book, 'Manning's Non-Euclidean Geometry.' (Boston, Ginn & Co., 1901, 8vo, pp. v + 95).

Saccheri's first proposition is (*American Mathematical Monthly*, June, 1894, Vol. I., p. 188).

"If two equal straights, *AC*, *BD*, make with the straight *AB* angles equal toward the same parts: I say the angles at the join *CD* will be mutually equal."

On the next page is "Proposition II. The quadrilateral *ABCD* remaining the same, the sides AB, CD are bisected in points *M* and *H*. I say the angles at the join *MH* will be on both sides right."

Professor Manning paraphrases these two together on page 5.

"If two equal lines in a plane are erected perpendicular to a given line, the line joining their extremities makes equal angles with them and is bisected at right angles by a third perpendicular erected midway between them."

Under the heading *Definitions*, Saccheri says: "Since (from our first) the straight joining the extremities of equal perpendiculars standing upon the same straight (which we will call base), makes equal angles with these perpendiculars, three hypotheses are to be distinguished according to the species of these angles.

"And the first, indeed, I will call hypothesis of right angle; the second, however, and the third I will call hypothesis of obtuse angle, and hypothesis of acute angle." This Manning paraphrases as follows, under the heading 'The Three Hypotheses:'

[TO BE CONTINUED.]

THE LIGHT CURVE OF THE NEW STAR IN PERSEUS.

CONTINUED FROM PAGE 552.

Date 1901.	Gr. M. T.	Observer.	Comparisons.	Magnitude. Obs'r.	Revised	Color
Mar.	h					
23	8.0	Robinson	κ, ν, δ	3.72	3.67	
	8.2	McClellan	κ, ν	4.20	4.19	
	10	Messow	N 1 ν; N 2 κ		3.9	W
	11.0	Gyllensköld	ν, ψ	4.11		
	13.5	Jones		4.09		
	15.4	Wendell	Photometer	3.75		
	15.4	Aitken		4.0		
24	4.2	Nijland		4.16		
	7.0	Deichmüller	ν 3.5 N			
	7.2	Plassmann	δ 7 N 2 ν		3.74	
	7.2	Harkányi	Photometer	4.45	4.22	R
	7.5	Fauth	ν 1 N 3 *l*; κ 2 N		4.32	
	7.5	Miclaucic		3.8		
	7.6	Sviatsky		4.6		
	7.7	Küstner	ν 2 N 1 κ; naked eye		3.98	
	7.9	Küstner	ν 2 κ 1 N 2 ξ; opera glass		4.01	
	8.0	Epstein	$\kappa > \nu > N > l$		4.5±	
	8.2	Archenhold	ν 4 κ 1 N	4.09	4.02	
	8.5	Robinson	ν, κ	4.20	4.19	
	8.6	Meyermann	ν, o	4.3		
	8.7	Ambronn	Photometer; ν, *l*	4.48		R
	8.8	Verschaffel	κ, ρ	4.2		
		Solá		4.2	3.9	
		Sharp		4.1		
	9.0	Plassmann	δ 8 N; ν 4 N; κ 3 N ! !		4.2	
	10.5	Plassmann	ν 5 N 3 ψ		4.14	
	10.6	Plassmann	ν 4.5 N 5 ψ		4.10	
	10.8	Jost	Photometer	4.27		
	13.0	Micou	*l* 1 N 2 (72)	5.2	5.15	
	13	Brenke	ν 1 N	4.0	4.0	
	13.8	Hagen	ξ 4 N 12 *l*		4.29	
	13.8	Zwack	ξ 1 N 14 *l*		4.12	
	14.2	Hagen	ξ 5 N 9 *l*		4.40	
	14.3	Zwack	ξ 3 N 12 *l*		4.25	
	15.5	Hagen	ξ 7 N 8 *l*		4.51	
	15.5	Zwack	ξ 5 N 11 *l*		4.35	
25	6.5	Müller	ν, κ	5.5		
	7.9	Robinson	*l* (72)	5.15	5.25	VR
	8	Graff	κ, ν	4.5		
	8.5	Gyllensköld	(70), *l*	5.33		
	8.5	Plassmann	*l* 6 N 6 (71)		5.20	
	8.9	Plassmann	*l* 5 N 5 (71)		5,20	
	9	Messow	Scarcely visible to naked eye			R
	9.0	McClellan		5		
	9.2	Williams	*l* 5 N 1 (71)	5.32	5.30	
		Sharp		5.2		D
		Oertel	(72)	5.5		
	9.4	Plassmann	*l* 4.5 N 4.5 (71)		5.2	
	10.0	Plassmann	*l* 5 N 5 (71)		5.2	
	10.1	Glasenapp	*l* 3 N = (72); N 2 (71), N 4 (83)		5.27	
	11.0	Glasenapp	*l* 4 N 1 (72); N 2 (71), N 4 (83)		5.27	
	12.6	Wendell	Photometer	5.31		
	15.6	Townley	*l* 1 N; κ 7-8 (72); *l* 2 (71)	5.2	5.15	
26	3.7	Nijland		4.64		

Date 1901.	Gr. M. T.	Observer.	Comparisons.	Magnitude. Obs'r.	Magnitude. Revised.	Color
	h					
	7.4	Honnorat		4.2		
	7.2	Gyllensköld	ψ, σ, (63), (70), (71), κ, ν	4.22		
	7.5	Ambronn	Photometer, ν, l	4.44		R
	7.7	Meyermann	ν, l, 40	4.3		
	7.9	Gyllensköld	ν, μ, l; ψ, σ, ν	4.21		
	8.0	Fauth	ν 2 N 3 l		4.37	
	8.5	Plassmann	ν 5 N 5 ψ		4.13	
	8.6	Robinson	κ, ν, l	4.20	4.26	
	9	Graff	c; decided red			R
	9	Epstein	N $>l$ and σ: almost $=\kappa$ and ν		4.2	
	9.2	Gyllensköld	ν μ ψ σ	4.04		
	9.7	Plassmann	ν 4.5 N 5.5 ψ		4.10	
	9.8	McClellan	κ ν	4.20	4.19	
	10	Soares		4.19		
	10.2	Jost	Photometer	4.25		
	10.2	Williams	ν 5 N $=\kappa$	4.22	4.00	*
	10.5	Luizet		4.1		
	10.5	Fowler		4.2		
	10.5	Lockyer		4.2		
	11.0	Wickham	η ν	4.03	3.99	†
	11.8	Williams	ν 4 N 3 κ	4.02	3.97	
	13	Micou	N $=\nu$ 3 N 2 κ	3.9	3.96	
	13	Olivier	N $=\nu$; 0.2 $>\kappa$; 0.3 $>\xi$; 0.1 $<o$; 0.2 $>\tau$		3.87	
	14.3	Hagen	ν 2 N 3 κ !		3.96	
	15.5	Hagen	ν 3 N 2 κ !		3.97	
	15.9	Zwack	N 3 ν		3.75	
	17.0	Townley	N 2 $\kappa\nu$; δ 6-7 κ	3.7	3.74	
27	3.7	Nijland		3.81		Y
	4.9	Nijland		3.77		
	6.6	Harkányi	Photometer	4.28	4.05	R
	7	Anckermann		4.4±		
	7.0	Gyllensköld	ν, κ, ψ, l (71)	4.54		
	7.2	Müller A	ν	4.0		
	7.7	Honnorat		4.1		
	7.7	Robinson	ν, κ	3.95	3.94	
	7.9	Valentiner	N $=\nu$, N 1 $<\kappa$		4.05	
	8 2	Plassmann	δ 7 N $=\nu$; N 4 κ		3.77	
	8.6	Wickham	ν, κ, η, τ	3.89	3.91	VR‡
	8.7	Riccò	Photometer: ϵ	4.23	4.00	
		Solá		4.0	3.7	
		Oertel	ν	3.9		
		Sharp		3.9		LO
	9.0	Gyllensköld	ψ, κ	4.10		
	9.5	Gyllensköld	ν, κ, ψ	4.03		
	9.6	Graff		4.2	4.1	
	10.0	Gyllensköld	κ, ψ, ν, l	4.13		
	10.3	Williams	ν 5 N 4 κ		3.97	R¶
		Lockyer		3.9		
	10.5	Robinson	ν, κ	4.15	4.14	
		Fowler		4.2		
	12.0	Robinson	ν, κ	4.15	4.14	VR
	13	Young	κ 1 N	4.2	4.1	
	13.3	Stebbins	N ξ; N ι, ($\nu\kappa$ 1 N 4 σ)	4.13	4.12	

* White with slight reddish tinge. † Red with yellowish tinge. † η also red. ¶ Redder than hitherto but not so pronounced as Mars or Aldebaran.

Date 1901.	Gr. M. T.	Observer.	Comparisons.	Magnitude. Obs'r.	Revised	Color
Mar.	h					
27	13.4	Wendell	Photometer	4.13		
	14.5	Comstock	N 1 σ; ν 5 N 2 *l*	4.6	4.59	
	14.8	Wilson	α 15 ϵ 1 γ 2 δ 1 β 3 ρ 5 κ 1 ν 1 N 1 θ 1 ι 1 σ		4.12	
28	3.2	Nijland		4.74		
	7	Anckermann		4.5±		
	7.0	Harkányi	Photometer	5.26	5.03	R
	7.0	Gyllensköld	ν, κ, ψ, σ	4.99		
	7.2	Müller A	σ	4.5		
	7.5	Honnorat		5.2		
	7.6	Valentiner	N 1 *l*		4.87	
	8.2	Wickham	ψ, σ	4.30	4.39	
	8.2	Robinson	*l*, ν, κ	4.73	4.79	
	8.2	Riccò	Notably $< \nu$	$<$4.03		
	8.5	McClellan	κ, *l*	4.60	4.72	
	8.7	Messow	N = *l*; κ 3 N; ψ 2 N; ξ 3 N; σ 1 N; N 2 (77)		4.98	
	8.7	Riccò	Photometer	4.78	4.55	
	8.8	Wickham	ψ, σ	4.55	4.64	
		Sharp		4.7		OR
	8.8	Luizet		5.1		
	8.9	Plassmann	ψ 4 N 2 *l*		4.74	
	9.0	Robinson	κ, ν, *l*	4.83	4.89	
	9.2	Wickham	ν, κ, ψ, σ, (70)	4.48	4.53	YR
	9.2	Plassmann	ψ 5 N		4.76	
	9.3	Schorr	N 1 *l*; N 3 (72); N 3 (71); σ 1 N; ψ 2 N		4.74	
	9.4	Messow	N 2 (71); N 3 (72); N 1 *l*; ψ 2 N; σ 3 N		4.87	
	9.4	Plassmann	ψ 5 N 3 *l*		4.73	
	9.4	Luizet		5.1		
		Fowler		5.3		
		Solá		5.5	5.0	
		Butler		5.3		
	9.8	Ambronn	ν 3 N 1 *l*	4.82	4.76	
	10.0	Gyllensköld	*l*, 31	4.86		
	10.0	Plassmann	ψ 2 N 4 *l*; κ 7 N		4.59	
	10.1	Plassmann	ψ 3 N 3.5 *l*; κ 7 N		4.66	
	11	Graff	κ, ν, σ, ψ	$<$ 4.5		
	11.0	Williams	κ 4 N	4.35	4.32	R
	12.5	Hagen	ξ 10 N 3 *l*		4.80	
	13	Micou	*l* 2 N 1 (72)	5.3	5.25	
	13.2	Stebbins	σ 1 N; [ν 1 N 3 *l*]; [N 1 *l* 1 (72)]	4.70	4.55	
	13.6	Zwack	ξ 6 N 10 *l*		4.42	
	13.7	Hagen	ξ 7 N 7 *l*		4.54	
	14.3	Wilson	κ = 1 ι 1 θ 1 σ 3 ψ = N = ω 3 *l*		4.67	
	16.0	Townley	ν κ 6-7 *l*; ν 7-8 *l*	4.8	4.74	
	16	Aitken		4.7		
	18	Aitken		5.0		
29	2.7	Nijland		4.54		
	4.0	Nijland		4.54		
	6.9	Harkányi	Photometer	5.13	5.00	
	7	Fauth	N 1 *l*		4.9	
	7.1	Luizet		4.8		
	7.2	Müller A	σ	4.5		
		Oertel		4.7		
	7.3	Plassmann	N = *l*; ψ 4 N 7 (83)		5.02	

Date 1901.	Gr. M. T.	Observer.	Comparisons.	Magnitude. Obs'r.	Revised.	Color
Mar.	h					
29	7.6	Riccò	Photometer	4.81		
	7.7	Ambronn	ν 5 N 1 *l*; N = *l*; ν 4 N 3 (72)	5.04	4.85	
	7.7	Valentiner	N = *l* to 1 > *l*		4.95	
	7.7	Verschaffel	*l*	4.9		
	7.8	Küstner	ψ 4 N 3 *l*		4.70	
	8.0	Riccò	< ν and κ	<4.03		
	8.1	Jost	Photometer	4.77		
	8.2	Köhl		5.36		
	9	Graff	σ	4.5		
	9	Epstien	N = σ; > *l*; < κ and ν		4.55	
		Solá		5.5	5.0	
	10	Soares		4.44		
	10.2	Williams	N 2 κ	3.75	3.90	R*
	13	Young	κ 1 N 2 σ	4.3	4.18	
	13.8	Hagen	ξ 7 N 12 *l*		4.30	
	14	Olivier		5.2		
	14.8	Zwack	ξ 7 N 12 *l*		4.41	
	14.8	Wendell	Photometer	4.57		
	15.8	Whitney	N = (63)	4.5	4.67	
	16.5	Townley	κ 5 *l*; ν 7 *l*	4.7	4.61	
	17	Aitken		5.0		
30	3.8	Nijland		4.23		
	5.1	Sviatsky		4.3		
	6.5	Robinson	κ, ν	4.15	4.13	†
	7.0	Müller A	ν	3.9		
	7.1	Harkányi	Photometer	4.34	4.18	
	7.2	Riccò	Photometer: ϵ	4.45	4.23	
	7.5	Riccò	A little < ν	<4.03		
		Oertel	ν *l*	4.3		
	7.5	Plassmann	ν 5 N 6 ψ		4.08	
	8	Graff	σ, ψ, *l*	4.1	4.0	
	8.5	Wickham	κ, ν, σ, ψ	4.18	4.22	
		Sharp		4.3		
		Kew	Two observers	4.2		
	9.0	McClellan	κ, ν	4.20	4.18	‡
	9.0	Robinson	κ, ν	4.15	4.13	
	9.8	Robinson	κ, ν, ι, θ	4.00	4.00	
	9.8	Soares		4.01		
	10 6	Robinson	κ, ν	4.20	4.18	
	11.5	Robinson	κ, ν	4.20	4.18	
	12.8	Jones		3.99		
	13.4	Daniel		4.33		
	13.5	Whitney	ι 2 or 3 N 3 ψ; N 2 σ	4.2	4.29	
	13.5	Furness	ν 2 N 2 or 3 ψ; ι 1 N	4.0	4.12	
	14.4	Wendell	Photometer	4.12		
	15.0	Wilson	κ 1 ν 1 N 1 ι 1 θ 1 σ 3 ψ = ω		4.11	
31	2.4	Nijland		4.54		
		Oertel	ν, *l*	4.4		
		Sharp		4.3		
		Kew	Two observers	4.3		
	7.6	Sviatsky		4.4		
	7.7	Harkányi	Photometer	4.63	4.48	
	8	Robinson	ν κ *l*	4.40	4.46	
	10.0	Williams	κ 4 N	4.35	4.32	
	13	Micou	*l* 3 N = (72)	5.4	5.35	

* Slightly reddish. † "Struck with absence of color." ‡ Not nearly so red as on Mar. 16.

Date 1901.	Gr. M. T.	Observer.	Comparisons.	Magnitude.		Color
				Obs'r.	Revised	
Mar.	h					
31	13-15	Olivier		4.6		
	13.2	Hagen	ξ 3 N 1 3 *l*; naked eye		4.23	
	13.2	Hagen	ξ 0 N; field-glass		4.05	
	13.5	Zwack	ν 7 N 11 ξ		3.94	
	13.8	Sperra	ν 4 N 2 ξ		4.01	
	14.0	Comstock	κ 4 N 2 σ; ν 2 N 2 ω	4.45	4.43	
	14.0	Stebbins	ν κ 1 N; N, ι; N, ξ; N, ν σ	4.15	4.13	
	14.5	Wilson	$\kappa = \nu$ 2 N = θ 1 σ 3 ψ		4.18	
	16.0	Townley	κ 3 *l*; ν 4 *l*	4.4	4.33	
	17	Aitken		4.7		
Apr.						
1	7	Anckermann		5.1±		
	7.6	Sviatsky		4.3		
	7.7	Robinson	ν, κ, ι, θ	4.09	4.09	
	7.7	Verschaffel	ν, κ, ι	4.1		
	7.8	Schorr	κ 2 N; ν 3 N 5 *l*; N 8 (72); N 1 ψ N 3 σ		4.25	
	8.7	Messow	κ 3 N; ν 4 N; ψ 2 N 4 *l*; N 7 (71) N 4 (77)		4.56	
	10.0	Williams	ν 6 N = κ	4.27	4.24	OY
		Sharp		4.7		OY
		Kew	Two observers	4.4		
	10.4	Luizet		4.1		
	11.1	Soares		4.13		
	11.1	Schorr	ν 4 N; κ ψ 3 N; 3 N; σ 1 N		4.71	
		Solá		4.5	4.1	
	12.2	Robinson	ν, κ	4.25	4.25	
	12.5	Hagen	κ 4 N 3 ξ ! !		4.03	
	12.6	Wendell	Photometer	4.11		
	13	Young	κ 1 N 2 σ	4.3	4.18	
	13.2	Daniel		4.42		
	13.5	Wilson	$\kappa = \nu =$ N; hazy		3.96	
	17.5	Aitken		4.5		
2	7	Graff	*l*, (71)	5.3	5.2	*
		Oertel	(72), *l*	5.5		
	7.2	Müller A	σ	4.7		R
	7.3	Meyermann	*l*, 25	5.3		
	7.5	Marchetti		5.0		
	7.7	Messow	*l* 1 N 2 (72); N 3 (71)		5.22	
	7.8	Schorr	(72) 3 N; *l* 5 N = 71; 11 ψ N; (63) 6 N; (67) 8 N; σ 10 N		5.50	
	9.2	Riccò	Photometer: ϵ	5.58	5.35	
	13.1	Wendell	Photometer	5.32		
	13.8	Comstock	*l* 2 N 1 (72); (71) 1 N	5.37	5.31	
	14.0	Stebbins	N (71); (72) 1 N; (κ 2 *l* 1 N)	5.47	5.45	
	15	Wilson	N invisible to eye			
3	7.0	Harkányi	Photometer	5.71	5.59	
	7.2	Müller Á	σ	4.7		R
	7.5	Höhl		5.1		
		Oertel	(72), (71), (82)	6		
	8.0	Valentiner	N = (71)		5.35	
	8.1	Riccò	Photometer: 725 PPD, ϵ	5.96	5.73	
	9	Anckermann		5.3		
	10	Graff	(71)	5.45	5.25	†
	13.3	Comstock	(72) 2 N	5.6	5.57	
	14.5	Parkhurst	Photometer	5.39		

* Intense lilac color. † Color less intense.

Date 1901	Gr. M. T.	Observer.	Comparisons.	Magnitude.		Color
				Obs'r.	Revised.	
Apr	h					
3	15.0	Stebbins	N (71), (72) 1 N	5.40	5.40	
	15.0	Wilson	*l* 5 (72) = N 1 (71)	5.29	5.33	
	15.5	Hadden		5.6		
	15.8	Townley	*l* 3-4 (72): (71) 3 N	5.3	5.26	
4	7.0	Lockyer	and two other observers	4.4		
	7.5	Meyermann	ν, *l*	4.5		
	7.7	Riccò	Photometer: 725 PPD, ϵ	4.66	4.43	
	8.2	Robinson	ν, κ, ι, θ	4.08	4.08	
		Solá		4.7	4.2	
		Sharp		4.5		OR
	10.1	Williams	ν 5 N 2 κ	4.12	3.98	O
	10.2	Archenhold	ν 4 κ 1 N	4.09	4.02	
	10.4	Graff	κ, ν, *l*	4.05	3.99	Y
	12.7	Hagen	ν 5 N 4 κ		3.97	
	13.5	Hagen	ν 5 N 4 κ		3.97	
	14	Brenke	N = ν > σ	4.0	3.9	
	15.5	Aitken		4.2		
5	7.4	Riccò	Photometer : ϵ, 725 PPD	4.88	4.65	
	7.7	Honnorat		5.8		
	7.8	Archenhold	κ 4 σ 2 N 2 *l*	4.86	4.79	
		Graff		4.5		Y*
		Solá		5.1	4.7	
	8.2	Verschaffel	ν, *l*	4.5		
	8.6	Robinson	ν, κ, *l*, (72)	4.28	4.33	
	9	Epstein	N = σ ; > *l*; < κ and ν		4.55	
	10	Soares		4.42		
	10.0	Lockyer		4.8		
	14	Young	κ 2 N 2 σ	4.3	4.28	
	16	Aitken		4.7		
6	7.5	Höhl		5.2		
	7.7	Riccò	Photometer; 725 PPD, ϵ	5.62	5.39	
	7.7	Luizet		4.4		
	8.0	Honnorat		6.0		
		Solá		5.9±		
	8.5	Lockyer		5.5		
	9.8	McClellan	*l*, (83)	5.60	5.75	
	17	Townley	*l* 8 (72); N 2 (72); N (72)	5.3	5.28	
	17	Aitken		5.0		
7	7.5	Höhl		5.4		
	7.5	Lockyer		6.0		
	7.5	Riccò	Photometer: ϵ	4.97	4.74	
	8 7	Robinson	(72), *l*, (83)	5.60	5.70	
	8.8	Küstner	(71) 2 N 1 (72)		5.36	
		Oertel	(72), (71), (82)	5.8		
	8.8	Verschaffel	DM 45°,778	5.7		
		Solá		6.3	5.5	
		Jost	N = (72)		5.37	
	9	Epstein	N = (72) : < (71)		5.37	
	9.5	Gyllensköld	(72), (82)	6.03		
	13	Micou	Near limit of visibility	5.6 :		
	15.2	Hadden	= (79)	5.7	5.81	
	17	Aitken		5.4		
	17	Townley	*l* 8 (72); N (71)	5.3	5.32	
8	6.1	Sviatsky		4.9		R‡
	7.3	Luizet		4.5		
	7.5	Pola	2 observers	4.2		

* Intensely yellow. ‡ Slightly red.

Date 1901	Gr. M. T.	Observer.	Comparisons.	Magnitude. Obs'r.	Revised	Color
Apr.	h					
8	7.8	Honnorat		5.0		
		Oertel	ν, *l*, κ	4.7		
	9.0	Meyermann	ν, *l*	4.5		
	9.3	Ambronn	ν 3 N 4 *l*	4.48	4.40	
	9.5	Epstein	N = κ > σ and *l*		4.00	
	9.5	Robinson	κ, ν, *l*	4.43	4.47	
	9.8	Wickham	κ, ν, ψ, σ, *l*	4.36	4.43	R*
	10.2	McClellan	κ, ν, *l*	4.50	4.54	
		Sharp		4.7		
	11.0	Lockyer		4.2		
	14	Parkhurst	Photometer	4.14		
	14	Brenke	μ 3 N = σ; κ 4 N	4.5	4.58	
	15	Wilson	κ 1 ν 2 N 2 σ 3 ψ		4.16	
	15.0	Comstock	($\kappa\sigma$) N; ν 2 N	4.20	4.28	
	15.8	Hadden	Same as ν	3.9	3.93	
	17	Townley	ν 1 κ 1 N	4.1	4.12	
	17	Aitken		4.2		
9	3.8	Stratanoff		4.63	4.50	
	6.6	Sviatsky		4.9		PR
	7-11	Müller, Kempf	Photometer: σ, *f*	4.55	4.62	RY
	7.2	Luizet		4.7		
	7.5	Pola	2 observers	4.2		
	7.8	Ambronn	ν 2 N 1 *l* clouds	4.73	4.67	
	8.0	Riccó	Photometer: 725 PPD, ϵ	5.17	4.94	
	8	Epstein	κ and ν > N > σ and *l*		4.4±	
	8.4	Archenhold	σ 4 ψ = N 4 *l*	4.48	4.61	
	8.5	Robinson	κ, ν, *l*	4.50	4.56	
		Jost	ν 2 N 3 *l*		4.37	
	8.8	Luizet		4.6		
	9.4	Archenhold	Perhaps $0^m.1$ brighter	4.38	4.51	
	9.5	Luizet		4.6		
	10	Soores		4.53		
	10.2	Wickham	σ, *l*	4.60	4.78	
	10.2	McClellan	κ, ν, *l*	4.63	4.69	
	11.5	Lockyer		4.7		
	13	Micon	N nearly = (72)		5.4	
	13.2	Olivier	0.3 > (71)		5.05	
	13.5	Sperra	σ 2 N 6-7 *l*; ξ 7 N		4.55	
	13.5	Parkhurst	Photometer	4.26		
	14	Comstock	N 2 σ; N ψ	4.25	4.26	
	15	Brenke	N 1 *l*	5.0		
	16	Aitken		5.0		
	16.0	Townley	ν 6-7 *l*; κ 5 *l*	4.6	4.58	
10	7.3	Riccò	Photometer: 725 PPD	5.67	5.34	
	7.7	Luizet		5.5		
	7.8	Ambronn	*l* 3 N 1 (72); κ 5 N 2 (72)	5.22	5.30	Y W
	8.0	Honnorat		5.8		
		Solá		6.0		
	8.0	Valentiner	*l* 1 N 1 (72)		5.20	
	8.1	Verschaffel	(71)	6.0		
	8.1	Luizet		5.4		
	8.2	Müller	Photometer: σ	5.57	5.61	RY
	8.2	Wickham	ψ, σ, ν, κ, *l* (72)	5.17	5.22	
	8.5	Meyermann	*l*, (72), (71)	5.22		
	8.8	Lockyer		5.7		

* Red with yellowish light in center of image; κ is bluish-white and α is white.

Date 1901.	Gr. M. T.	Observer.	Comparisons.	Magnitude. Obs'r.	Revised.	Color
Apr.	h					
10	9.2	Robinson	(71) (83) γ	5.47	5.54	
	9.8	McClellan	*l*	5.34	5.53	
		Sharp		5.3		
	10	Epstein	N = *l* and (71); < σ		5.18	
	10.4	Müller	Photometer: *f*	5.62	5.71	
	10.7	Messow		5.6		
	13.3	Micou	*l* 5 N; (72) 2 N; (71) 3 N	5.6	5.58	RY
	13.3	Whitney	N = (72)	5.4	5.37	
	13.5	Olivier	0.2 < (71)		5.55	
	14.0	Comstock	(72) 1 N	5.5	5.47	
	14.0	Parkhurst	Photometer	5.48		
	16.2	Wilson	κ 5 *l* 5 (72) 2 N 2 (71) 5 (83)		5.41	
	17	Aitken		5.5		
11	1.0	Nijland		5.3		
	3.1	Stratanoff		5.52	5.35	
		Oertel	*l*, (72), (71)	5.4		
	7.4	Luizet		5.7		
	7.5	Höhl		5.4		
	7.5	Miclaucic		5.3		
	7.6	Müller	Photometer: *f*, (76)	5.85	5.90	
	8.0	Archenhold	71 1 N = (72)	5.55	5.37	
	8	Epstein	N = (71) < (72)		5.35	
		Lockyer		5.8		
		Solá		6.2	5.4	
		Oertel	*l*, (72), (71)	5.4		
	9.0	Müller, Kempf	Photometer: (76), (85)	5.69	5.87	
	12.5	Hagen	N 0 (72)		5.37	
	13	Micou		5.6		
	13.2	Zwack	*l* 7 N 2 (72)		5.30	
	13.5	Sperra	*l* 6—7 N		5.36	
	14.0	Hagen	N 0 72		5.37	
	14.4	Daniel		5.40		
	16-18	Aitken		5.7		
12	7.3	Riccò	Photometer : 725 PPD, ϵ	5.50	5.27	
	7.5	Ambronn	= *l* or a little >	5.08	5.0	
	7.6	Sviatsky		5.0		
	8	Müller	Photometer : *l*	(5.0)	5.0	
	8.1	Meyermann	*l*, (72), ν	4.85		
	8.6	Archenhold	ψ 3 N 1 *l*	4.87	4.84	
	8.8	Lockyer		5.2		
	9.1	Meyermann	*l*, (72)	4.95		
		Solá		5.7	5.1	
		Sharp		4.7		
	9.5	Robinson	ν, κ, *l*	4.70	4.76	R*
	9.6	Williams	κ 5 N 1 *l*; N 5 (71)	4.7	4.75	R†
	9.7	Lockyer		4.9		
	9.8	McClellan	*l*, κ, ν	4.63	4.69	
	9.8	Soares		4.67		
	9.9	Williams				W
		Harvard		4.6		
	14	Young	κ 2 N 2 σ	4.3	4.28	
	14.5	Whitney	ψ 1 N; σ 1 N	4.3	4.50	
	14.8	Whitney	κ N *l*	4.6	4.52	
	17	Townley	κ 2-3 N	4.3	4.25	
13	7.0	Müller A	σ	5.5		

* But not very red. † Fairly deep reddish.

ASTRONOMICAL PHENOMENA DURING 1902.

Eclipses.

In the year 1902, according to the *American Ephemeris*, there will be five eclipses, three of the Sun and two of the Moon. Of these only one, a total eclipse of the Moon, Oct. 16, will be visible in the United States. The eclipses of the Sun are of little astronomical importance, all being partial eclipses.

1. A Partial Eclipse of the Sun April 8. This is a very slight eclipse, only 0.065 of the diameter of the Sun being covered by the Moon at greatest obscuration. It will only be visible in high northern latitudes of North America.

2. A Total Eclipse of the Moon, April 22. This will be visible, the beginning in Asia and the eastern parts of Europe and Africa and the ending throughout Europe, Asia and Africa.

Elements of the Eclipse.

Greenwich Mean Time of opposition in right ascension, April 22d 7h 00m 54s.9

Sun's right ascension	1h	58m	09s.47	Hourly motions			9s.35	
Moon's right ascension	13	58	09 .47	Hourly motion			120 .20	
Sun's declination	12°	04′	17″.2 N	Hourly motion		0′	50″.6 N	
Moon's declination	12	19	25 .9 S	Hourly motion		7	51 .0 S	
Sun's equa. hor. parallax			8 .7	Sun's true semidiam.		15	54 .3	
Moon's equa. hor. parallax		54	40 .3	Moon's true	"	14	53 .9	

Circumstances of the Eclipse.

Moon enters penumbra	April	22d	03h	49m.0	Greenwich Mean Time.
Moon enters shadow		22	05	00 .1	
Total eclipse begins		22	06	10 .1	
Middle of the eclipse		22	06	52 .8	
Total eclipse ends		22	07	35 .5	
Moon leaves shadow		22	08	45 .5	
Moon leaves penumbra		22	09	57 .0	

Contacts of shadow with Moon's limb.	Angles of position from north point.	The Moon being in the zenith in longitude from Greenwich.	and in latitude.
First	89° to E.	103° 43′ E.	12° 04′ S.
Last	69 to W.	49 06 E.	12 33 S.

Magnitude of the eclipse = 1.338 (Moon's diameter = 1.0).

3. A Partial Eclipse of the Sun, 1902, May 7, invisible at Washington. This will be visible only in the southern part of the Pacific Ocean, the Islands of New Zealand being practically the only land within the eclipsed area.

Elements of the Eclipse.

Greenwich Mean Time of conjunction in right ascension, May 7d 10h 12m 15s.6

Sun and Moon's R. A.	2h	55m	42s.04	Hourly motions		9s.68 & 153s.70		
Sun's declination	16°	44′	50″.4N	Hourly motion		0′	41″.6 N	
Moon's declination	15	37	34 .4E	Hourly motion		7	31 .2 N	
Sun's equa. hor. parallax			8 .7	Sun's true semidiam.		15	50 .6	
Moon's equa. hor. "		61	02 .1	Moon's true	"	16	38 .0	

Circumstances of the Eclipse.

	Greenwich Mean Time.			Longitude from Greenwich.			Latitude.		
Eclipse begins	May 7d	08h	42m.5	161°	53′.8	E	52°	53′.5	S
Greatest eclipse	7	10	34 .3	125	16 .7	W	70	00 .1	S
Eclipse ends	7	12	26 .3	108	29 .7	W	32	24 .7	S

Magnitude of greatest eclipse = 0.858 (Sun's diameter = 1.0).

4. A Total Eclipse of the Moon, 1902 October 16, visible at Washington; the beginning visible generally in North and South America and the western portions of Europe and Africa; the ending visible generally in North and South America, and the extreme northeast portions of Asia.

ELEMENTS OF THE ECLIPSE.

Greenwich Mean Time of opposition in right ascension, October $16^d\ 18^h\ 10^m\ 12^s.7$

Sun's right ascension	13^h	24^m	$52^s.58$	Hourly motion			$9^s.33$	
Moon's right ascension	1	24	52 .58	Hourly motion		138	31	
Sun's declination	8°	55′	20″.5 S	Hourly motion		0′	55″.2	S
Moon's declination	9	08	52 .7 N	Hourly motion		10	06 .4	N
Sun's equa. hor. parallax			8 .8	Sun's true semidiam.		16	03 .1	
Moon's equa. hor. parallax		59	13 .2	Moon's true	"	16	08 .3	

CIRCUMSTANCES OF THE ECLIPSE.

Moon enters penumbra	October 16^d	15^h	$17^m.1$	Greenwich Mean Time
Moon enters shadow	16	16	17 .3	
Total eclipse begins	16	17	19 .0	
Middle of the eclipse	16	18	03 .4	
Total eclipse ends	16	18	47 .9	
Moon leaves shadow	16	19	49 .7	
Moon leaves penumbra	16	20	50 .0	

Contacts of shadow with Moon's limb.	Angles of position from north point.	The Moon being in the zenith in longitude from Greenwich.	and in latitude.
First	86° to E	68° 56′ W	8° 50′ N
Last	118 to W	120 08 W	8 25 N

Magnitude of the eclipse = 1.464 (Moon's diameter = 1.0)

5. A Partial Eclipse of the Sun, 1902 October 30, invisible at Washington. This will be visible through the greater part of Europe and Asia. It ends just after sunrise at London and is not visible in the western part of England and Scotland. The southern limit of eclipse passes across France, Austria, Turkey, Arabia, Hindostan and Siam. The eclipse ends at sunset in China.

ELEMENTS OF THE ECLIPSE.

Greenwich Mean Time of conjunction in right ascension, October $30^d\ 19^h\ 28^m\ 19^s.80$

Sun and Moon's R. A.	14^h	18^h	$24^m.66$	Hourly motion		$9^s.74$ &	$123^s.80$	
Sun's declination	13°	50′	17″.1 S	Hourly motion		0′	49″.2	S
Moon's declination	12	44	44 .8 S	Hourly motion		7	29 .9	S
Sun's equa. hor. parallax			8 .9	Sun's true semidiam.		16	06 .8	
Moon's equa. hor. parallax		55	18 .3	Moon's true	"	15	04 .2	

CIRCUMSTANCES OF THE ECLIPSE.

		Greenwich Mean Time.			Longitude from Greenwich.		Latitude.	
Eclipse begins	October	30^d	17^h	$58^m.6$	19° 51′.7 E		58° 24′.7	N
Greatest eclipse		30	20	00 .3	100 39 .7 E		70 50 .4	N
Eclipse ends		30	22	02 .4	106 02 .6 E		33 12 .6	N

Magnitude of greatest eclipse = 0.696 (Sun's diameter = 1.0).

THE PLANETS.

The apparent paths of the major planets through the constellations of the Zodiac during 1902 are shown in the cuts Figs. 1 to 3. *Mercury* begins the year in Sagittarius, about 13° farther east than last year, and pursues a somewhat similar course, making a great closed loop in Aquarius during February, an-

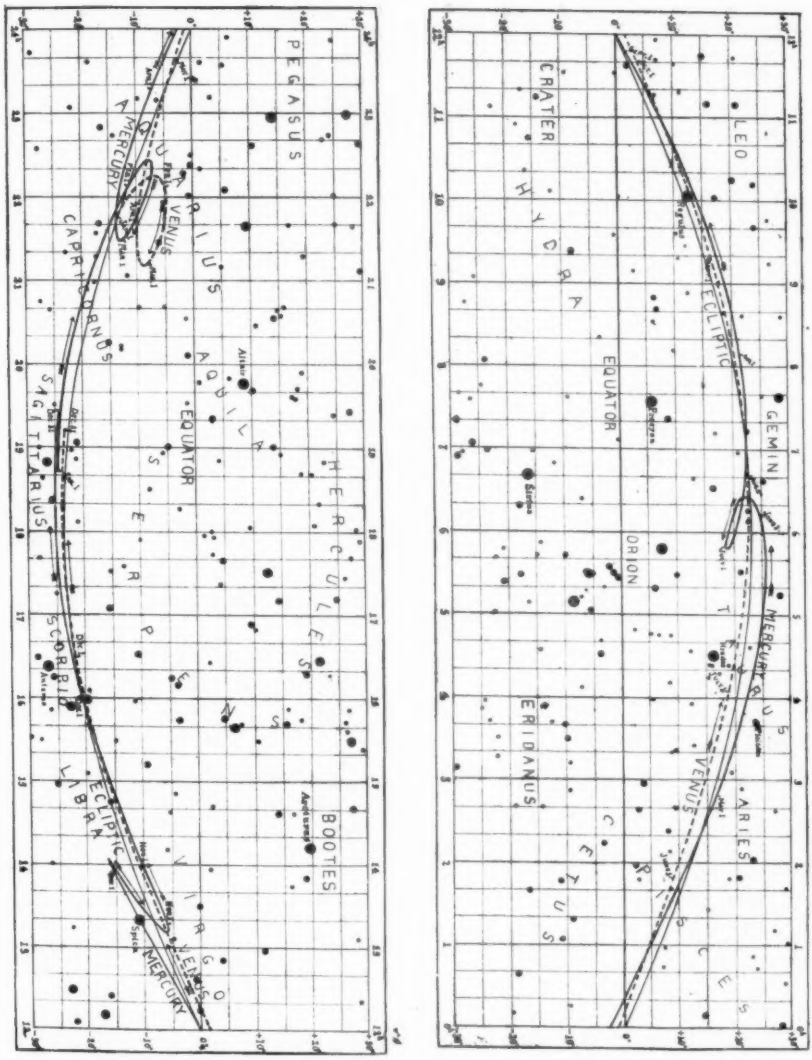


FIG. 1. DIAGRAM SHOWING THE APPARENT PATHS OF THE PLANETS MERCURY AND VENUS DURING 1902.

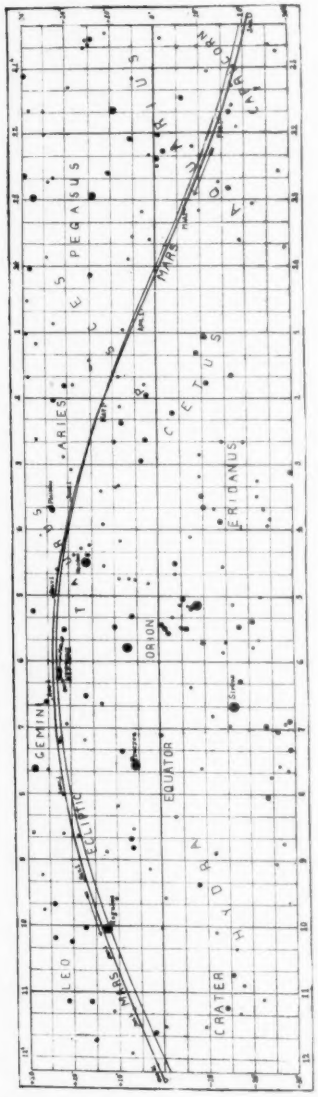


FIG. 2. DIAGRAM SHOWING THE APPARENT PATHS OF MARS AND NEPTUNE DURING THE YEAR 1902.

other great loop, narrower than that of last year, in Gemini and finally a reversed *S* in Virgo, the lower part of the *S* being narrower than that of last year. The planet's course ends in Sagittarius, about 12° east of the starting point.

Mercury will be visible as evening star in the first part of February, the latter part of May and in September. It may be seen as morning star in April, July and November.

Venus begins the year as evening star and will be at her greatest brilliancy January 10th. During the first three months of the year she turns a great loop in Aquarius, almost parallel with, but north of, that made by Mercury. During this time Venus will pass between the Earth and the Sun, conjunction occurring on Feb. 14. The planet will reappear as morning star a few days later and will continue to be very conspicuous in the morning throughout the spring and summer. Her greatest brilliancy as morning planet will be attained in March. In the diagram the dotted curve represents the path of Venus.

The path of *Mars* contains no loops this year. During the first half of the year the planet will be too near the Sun for observation, conjunction occurring Mar. 29; during the latter half it may be observed in the morning. Mars will reach quadrature, 90° west from the Sun, Dec. 22.

Jupiter and *Saturn* will continue to be near neighbors, gradually separating during the year. Both move eastward during the winter and spring, retrograde during the summer and advance again in the autumn and winter. Throughout the year their meridian altitude will be too low for satisfactory observation. Saturn will be at conjunction Jan. 9 and Jupiter will be in the same position Jan. 15. The opposition of Saturn will occur on July 17, that of Jupiter, Aug. 5. The plane of the satellite orbits of Jupiter is so situated that the satellites in passing between the Earth and the planet transit north of Jupiter's equator,

Satellite IV crossing the planet's disc about half way from the center to the north edge. The inclination of the plane of the rings of Saturn to the line of sight from the Earth varies between 21° and 24° during the year. We look upon the north side of the rings.

Uranus describes a short path between Scorpio and Sagittarius, moving eastward until March 25, then retrograding until August 27, and again moving eastward for the remainder of the year.

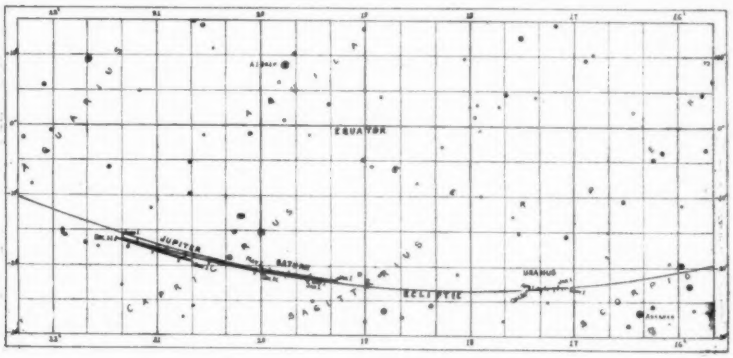


FIG. 3. CHART SHOWING THE APPARENT PATHS OF JUPITER, SATURN AND URANUS DURING 1902.

Neptune's path is shown on the chart with that of Mars. The motion is retrograde until March 10 then eastward until Oct. 7, then retrograde for the rest the year. From July to December its course lies between the stars η and μ Geminorum and from 12′ to 17′ south of these stars. It may therefore be easily found by means of these stars if the observer with a small telescope will make a chart of the small stars in their vicinity. Neptune will be in conjunction with η on July 18, but it will then be near the Sun and therefore invisible.

COMETS.

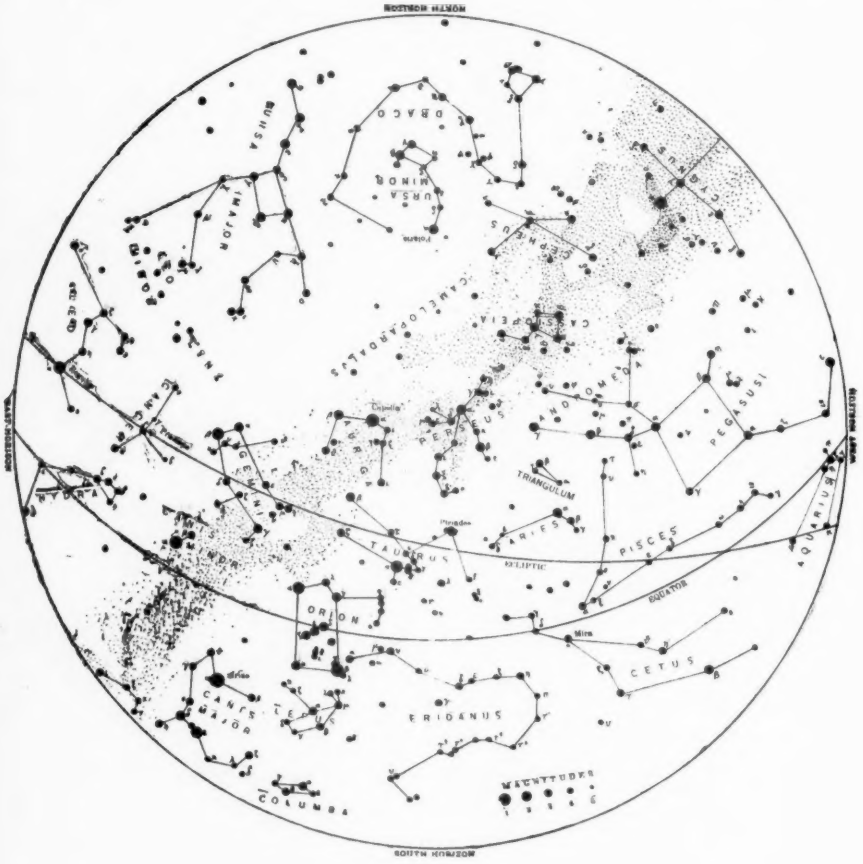
Two of the short period comets are due to return to perihelion during this year.

1. Swift's comet 1895 II, discovered by Lewis Swift Aug. 21, 1895, was found to be moving in an orbit of 7.22 years period. It should therefore be at perihelion again in the early part of November of this year. Its position will not be so favorable as in 1895 since the Earth will in November be far past the line joining the comet and the Sun. The comet may perhaps be found during the summer, but it faded away so quickly in 1895 that it seems quite doubtful whether it will be possible to see the comet at the much greater distance this year.

2. The comet known as Temple-Swift, discovered by Temple in 1869 and rediscovered by Swift in 1880, observed again by Barnard and others in 1891, will come to perihelion in the early part of December. Its position is fairly favorable and the comet will probably be found some time before it reaches perihelion.

METEOR SHOWERS.

The brilliancy of the Leonid shower last November leads us to more confi-t dently anticipate one worth observing in November 1902. The Earth is due a



THE CONSTELLATIONS AT 9 P. M., JANUARY 1, 1902.

the crossing of the swarm, Nov. 15 at about 3 P. M. Central Standard Time, but the width of the swarm is so great that a few meteors are to be expected for several nights on either side of that time. The full Moon will, however, detract much from the brilliancy of the meteors.

Mr. Denning gives in the Companion to the Observatory a list of 90 radiant points of different meteor showers during each year. The more brilliant of these are the following:

PLATE V.

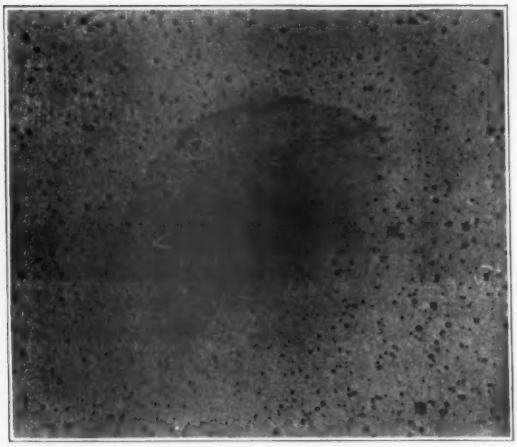


FIG. 1—PHOTOGRAPH MADE WITH TWO-FOOT REFLECTOR.
Exposure 3h 50m.

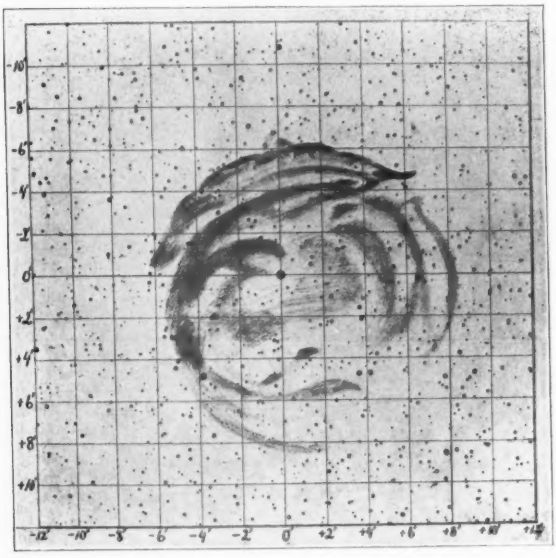


FIG. 2.—DIAGRAM FROM ORIGINAL NEGATIVE.

NEBULOSITY AROUND *NOVA PERSEI*, Sept. 20, 1901.

By G. W. RITCHEY, Yerkes Observatory.

[Reprinted from the Astrophysical Journal for Nov. 1901.]

PLATE VI.

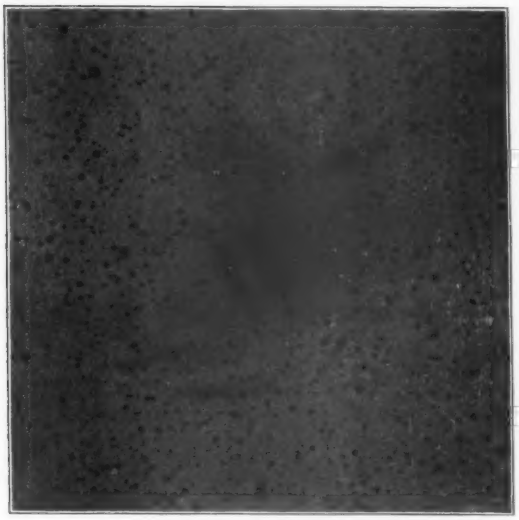


FIG. 1.—PHOTOGRAPH MADE WITH TWO-FOOT REFLECTOR.
Exposure 7h.

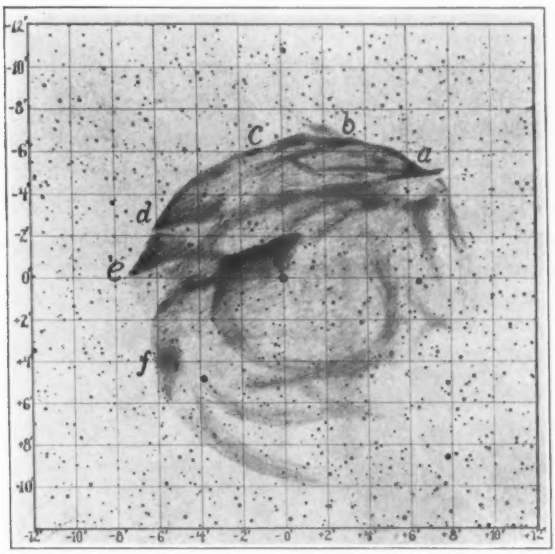


FIG. 2.—DIAGRAM FROM ORIGINAL NEGATIVE.

NEBULOSITY AROUND *NOVA PERSEI*, NOV. 13, 1901.

By G. W. RITCHEY, Yerkes Observatory.

[Reprinted from the Astrophysical Journal for Nov. 1901.]

Date.	Radiant. α	Radiant. δ	Remarks.
Jan. 2—3	230°	+ 53°	Swift long paths.
Apr. 20—21	270	+ 33	Swift.
Mar. 6	338	— 2	Swift; streaks.
July 28	339	— 12	Slow; long.
Aug. 11	44	+ 57	Swift; streaks. The Perseids.
Oct. 18—20	92	+ 15	Swift; streaks.
Nov. 14—16	150	+ 22	Swift; streaks. The Lsonids.
Nov. 23—24	25	+ 44	Very slow; trains. The Andromedes.
Dec. 10—12	108	+ 33	Swift; short.

The Perseid shower, with maximum on Aug. 11 lasts for a considerable period and the radiant point moves E. N. E. among the stars about 1° per day. Its position July 20 should be α 20°, δ + 51° and on Aug. 17 α 53°, δ + 58°.

OCCULTATIONS.

A list of 100 occultations, visible at Washington and hence most of them visible throughout the United States is given in the *American Ephemeris* for 1902, and we shall publish portions of this list monthly in POPULAR ASTRONOMY. The list for January is as follows:

Occultations Visible at Washington.

Date. 1901.	Star's Name.	Magnitude.	IMMERSION. Washington M.T. h	m	Angle f'm N pt. °	EMERSION. Washington M. T. h	m	Angle f'm N pt. °	Duration. h	m
Jan. 1	56 Virginis	7.0	16	14	67	17	08	349	0	54
11	ν Aquarii	4.6	7	06	44	7	58	274	0	52
14	λ Piscium	4.7	8	15	29	9	06	286	0	51
19	W.B. (2),IV,248	5.9	6	17	118	7	17	219	1	00
19	B.A.C. 1361	6.5	8	49	91	10	08	258	1	19
19	ε Tauri	3.6	10	54	74	12	03	285	1	09
20	B.A.C. 1796	7.5	16	15	148	16	46	226	0	31
20	127 Tauri	6.3	16	23	146	16	55	228	0	32
23	A^2 Cancri	5.8	18	23	67	19	02	330	0	39
31	28 Libræ	6.0	15	37	162	16	26	237	0	49

VARIABLE STARS.

Two New Variable Stars 91 and 92, 1901.—These are announced by Mr. A. W. Roberts in *A. J.* 508. The first is in the constellation Vela in R. A. $10^h\ 16^m\ 44^s$; Decl. — 41° 43′.8 (1875). It is of the Algol type and varies between 10.0 and 10.9 magnitude in a period of $1^d\ 20^h\ 30^m\ 2^s$. The second is in Corona Australis, in R. A. $18^h\ 32^m\ 45^s$; Decl. — 37° 35′.8 (1875), apparently variable between 8.0 and 9.0 magnitude, with a period of 185 days.

New Variable 93.1901 Sagittæ.—This is announced by F. Schwab of Ilmenau in *A. N.* 3748. It is BD + 19°,3975, R. A. $19^h\ 14^m\ 26^s$; Decl. + 19° 25′.4 (1900). The variable is of the Algol type, having an ordinary brightness of $6^m.5$, sinking at minimum to about $9^m.0$, remaining there for some time unchanged, then rapidly recovering its ordinary brightness. The period is about 17 days and the light curve seems very similar to that of U Cephei.

New Variable 94,1901 Cygni.—This is BD + 41°.4114, R. A. $21^h\ 17^m\ 42^s$; Decl. + 41° 51′.8 (1875.0) and was discovered by Fr. Deichmüller of Bonn. The period and range of variation are yet unknown, but its ordinary magnitude is about 9.0, while on Nov. 4 and 5, 1901, it was about 10.0.

New Variable 95,1901 Pegasi.—This was discovered by Rev. T. D. Anderson of Edinburg. It is BD + 24°.4462, R. A. 21^h 37^m 56^s; Decl. + 24° 20′.6 (1855), magnitude 9.3. It was invisible in a 3-inch telescope Aug. 24 and on every occasion when searched for since that time until Nov. 16, when it was of exactly the same brightness with a neighboring 10^m star.

Minima of Variable Stars of the Algol Type.

[Greenwich Mean Time beginning with midnight. The hours greater than 12 are those of the afternoon. To obtain Eastern Standard time subtract 5 hours; for Central Standard subtract 6 hours.]

U Cephei.

d	h
Jan. 3	6
5	18
8	6
10	17
13	5
15	17
18	5
20	17
23	5
25	16
28	4
30	16

Algol.

Jan. 3	3
5	23
8	20
11	17
14	14
17	11
20	7
23	4
26	1
28	22
31	19

λ Tauri.

Jan. 1	19
5	18
9	17
13	15
17	14
21	13
25	12
29	11

R Canis Maj.

Jan. 1	15
2	18
3	22
5	1
6	4
7	7
8	11
9	14
10	17
11	21

R Can. Maj. Cont.

d	h
Jan. 13	0
14	3
15	6
16	10
17	13
18	16
19	19
20	23
22	2
23	5
24	8
25	11
26	15
27	18
28	21
30	0
31	3

S Cancri.

Jan. 9	3
18	15
28	3

δ Libræ.

Jan. 2	3
4	10
6	18
9	2
11	10
13	18
16	2
18	9
20	17
23	1
25	9
27	17
30	1

U Coronæ.

Jan. 4	2
7	13
11	0
14	11
17	22
21	9
24	19
28	6
31	17

Z Herculis.

d	h
Jan. 2	2
4	1
6	2
8	0
10	2
12	0
14	2
16	0
18	1
20	0
22	1
24	0
26	1
28	0
30	1
31	23

V^2 Cygni.

Jan. 6	6
12	6
18	6
24	6
30	6

U^3 Cygni.

Jan. 2	10
7	0
11	14
16	3
20	17
25	7
29	21

W Delphini.

Jan. 1	23
6	19
11	14
16	10
21	5
26	0
30	20

Y Cygni.

Jan. 1	1
2	8
4	1
5	7
7	0
8	7

Y Cygni, Cont.

d	h
Jan. 10	1
11	7
13	0
14	7
16	1
17	7
19	0
20	7
22	1
23	7
25	0
26	7
28	1
29	7
31	0

S Antliæ.

Period 7^h 46^m.8

Jan. 1	1
2	1
3	0
3	23
4	23
5	22
6	21
7	21
8	20
9	19
10	19
11	18
12	17
13	17
14	16
15	15
16	15
17	14
18	13
19	13
20	12
21	11
22	11
23	10
24	9
25	9
26	8
27	7
28	7
29	6
30	5
31	5

Maxima and Minima of Long Period Variables.

[Computed from Chandler's "Third Catalogue" by Misses Ida I. Watson and Helen M. Swartz of Vassar College Observatory.]

Maxima.			Maxima.			Minima.		
Date Jan.	No.	Star.	Date Jan.	No.	Star.	Date Jan.	No	Star.
2	1981	S Camelopar.	16	1761	R Orionis	3	4511	T Ursæ Maj.
2	8153	R Lacertæ	16:	5249	V Libræ	3	6849	R Aquilæ
6	6682	X Ophiuchi	16:	5903	Y Scorpii	7	466	U Piscium
6	7242	S Aquilæ	18:	1805	V Orionis	14	976	T Arietis
8	2625	V Geminorum	18	5617	U Libræ	17	893	U Ceti
8	2946	R Cancri	18	7428	V Cygni	17	2258	V Aurigæ
9	6512	T Herculis	20	3493	R Leonis	24	5583	X Libræ
9	8512	R Aquarii	23	243	U Cassiopeæ	26:	294	W Cassiopeæ
12	7455	U Capricorni	23	8324	V Cassiopeæ	28	8068	S Lacertæ
14	7733	Y Capricorni	24	2742	S Geminorum	29	5887	V Ophiuchi
15	7571	V Capricorni	25	3994	S Leonis	29	7085	R T Cygni
16	1717	V Tauri	29	8230	S Aquarii	31	1582	S Tauri

Observations of Nova Persei.

Y	M	D	h	m	Jul Day	Comparison.	
1901	10	15	8	50	2415673	$g\ 1\frac{1}{2}$ v $1\frac{1}{2}$ h	
"	"	16	8	20	74	g 2 v 1 h	
"	"	"	8	40	"	$g\ 1\frac{1}{2}$ v 1 h	2d obs.
"	"	20	8	15	78	g 2 v $1\frac{1}{2}$ h	
"	"	21	8	15	79	v = h	
"	"	28	8	15	86	h 1 v 2 k	
"	"	"	8	30	"	$h\ \frac{1}{2}$ v 2 k	2d obs. Moonlight and clouds.
"	"	29	8	5	87	h 1 v $1\frac{1}{2}$ k	
"	"	30	8	40	88	h 1 v 2 k	Partly cloudy.
"	"	"	8	55	"	h 1 v $1\frac{1}{2}$ k	2d obs.
"	11	2	7	45	91	v = h	
"	"	"	8	15	"	v = h	2d obs.
"	"	3	7	40	92	v = h	
"	"	4	8	45	93	$h\ \frac{1}{2}$ v $1\frac{1}{2}$ k	
"	"	9	8	30	98	$h\ \frac{1}{2}$ v 2 k	
"	"	10	6	55	99	$h\ \frac{1}{2}$ v $1\frac{1}{2}$ k	
"	"	19	9	35	2415708	h 2 v 1 k	
"	"	20	6	0	09	h 2 v 1 k	
"	"	"	7	40	"	$h\ 1\frac{1}{2}$ v $1\frac{1}{2}$ k	2d obs.
"	"	21	7	30	10	h 2 v 1 k	
"	"	27	8	0	16	$h\ 2\frac{1}{2}$ v 1 k	
"	"	"	8	10	"	h 3 v $\frac{1}{2}$ k	2d obs.
"	"	28	6	50	17	$h\ 1\frac{1}{2}$ v 2 k	
"	"	"	8	5	"	$h\ 1\frac{1}{2}$ v $1\frac{1}{2}$ k	2d obs.
"	"	30	8	30	19	h 2 v $1\frac{1}{2}$ k	
"	12	1	6	45	20	$h\ 1\frac{1}{2}$ v 2 k	
"	"	"	8	5	"	h 2 v $1\frac{1}{2}$ k	2d obs.
"	"	2	8	15	21	h 2 v $1\frac{1}{2}$ k	
"	"	"	8	30	"	$h\ 1\frac{1}{2}$ v $1\frac{1}{2}$ k	2d obs.

PROVIDENCE, Dec. 3d, 1901. F. E. SEAGRAVE.

The Color Variation of Nova Persei.—In *A. N.* 3751 Mr. H. Osthoff of Cöln, Germany, gives an interesting discussion of the color changes of Nova Persei. By representing the successive colors of the spectrum numerically he has constructed a color curve similar to the light curve and shows that the variations of the two curves were very nearly parallel.

The Nova Persei Nebulosity.—We are glad to present by the courtesy of Professor George E. Hale, Director of the Yerkes Observatory, the four half tone cuts, Plates V and VI. They were prepared from two of the negatives taken by Mr. G. W. Ritchey, to which we referred last month. The comparison of the two photographs taken fifty days apart shows very plainly the motion of the nebular condensations south of (above in the cuts) the star. These with the article by Mr. Perrine given in this number of POPULAR ASTRONOMY will put before our readers the latest phases of the observed phenomena of this wonderful star. The last photograph by Mr. Ritchey seems to indicate that the outer nebular condensations are diminishing in brightness and that the nebulosity may therefore not be permanent. The diagrams drawn by Mr. Ritchey show much more of the details of the nebula than could be reproduced directly from the original negatives.

A telegram from Lick Observatory states that on a photograph taken Dec 4 with the Crossley reflector Perrine finds the motion of condensation *a* and *b* continued; the motion of condensation *c* apparently continued but the form changed; condensation *d* apparently unchanged.

GENERAL NOTES.

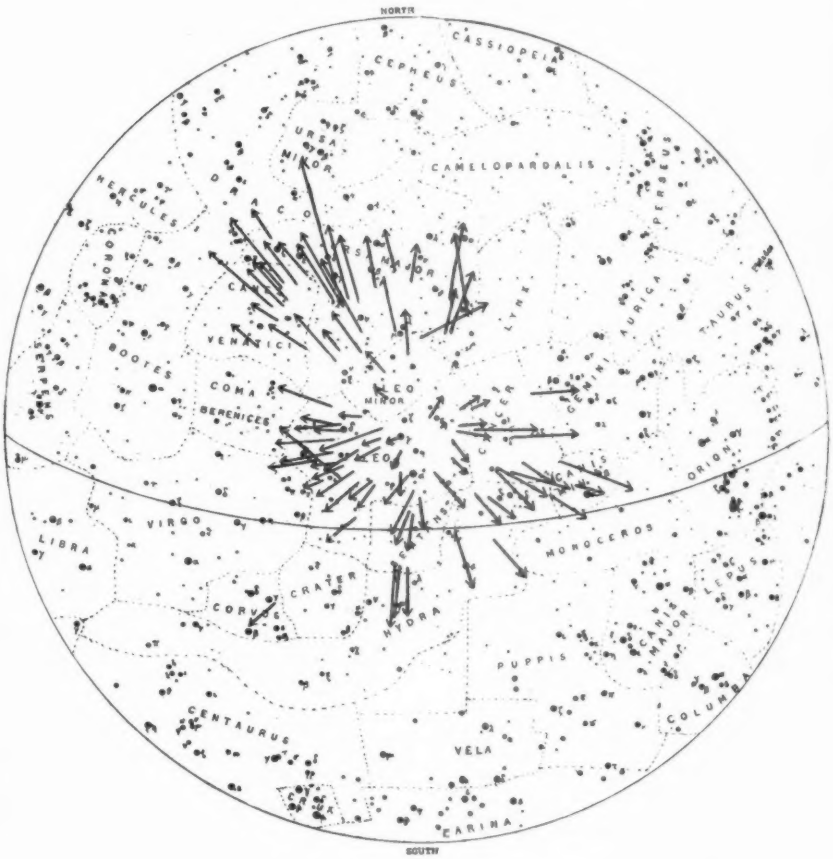
Our readers will be interested in the leading article this month by Professor A. N. Skinner of the United States Naval Observatory. Professor Skinner was in charge of the Government Expedition to Sumatra for the purpose of observing the total solar eclipse of May 18, 1901. A note following the article explains why the article was delayed in reaching us.

The January number of this publication usually contains so full an account of the important phenomena of the year that small space is left for the various general notes that our readers might naturally expect. This number is not an exception to the rule.

Observations of Leonids, November, 1901, at Ladd Observatory.—Observations were planned for four mornings, Nov. 14-17 civil time. Cloudy weather prevailed on the 14th and 17th, but the sky was clear on the 15th and 16th. The observations were confined to the region within 40° or 50° of Leo. Careful count of the number was kept, and the paths charted of those which were noted with sufficient accuracy. Several cameras were also in use, two kept upon the radiant point by clock motion, and two others pointed to adjacent regions. The following table gives the result of the count:

	November 15.			November 16.		
Eastern Time.	Leonids.	Others.	Total.	Leonids.	Others.	Total.
12 —12:30	2	2	4	—	—	—
12:30— 1:00	6	0	6	1	10	11
1:00— 1:30	3	1	4	4	5	9
1:30— 2:00	2	2	4	7	6	13
2:00— 2:30	10	2	12	11	6	17
2:30— 3:00	10	4	14	10	6	16
3:00— 3:30	34	1	35	6	7	13
3:30— 4:00	58	7	65	7	4	11
4:00— 4:30	61	7	68	5	2	7
4:30— 5:00	66	7	73	—	—	—
5:00— 5:30	60	8	68	—	—	—
Sum	312	41	353	51	46	97

On November 15th there was a marked increase in number beginning about 3:00 A. M. and continuing until daylight. The rate exceeded two per minute. A few only were brighter than the first magnitude, but many were estimated to be of the first, second and third magnitudes. No trails were photographed as the



LEONIDS CHARTED AT LADD OBSERVATORY, PROVIDENCE, R. I., NOV. 15, 1901. 0:30—5:30 A. M.

most brilliant meteors were beyond the region covered by cameras. The brightest meteor was seen at 5:08 eastern time; it was a Leonid which moved from Ursa Major into Ursa Minor, was estimated to be of the — 2d magnitude and left a trail lasting over two minutes.

The paths of 88 meteors were carefully charted and the radiant point determined of three groups as follows:

Eastern Time.	No.	R. A.	Decl.
0:35—3:00	26	$10^h\ 7^m.3$	$+22°\ 45'$
3:00—4:00	31	10 0 .0	22 4
4:00—5:30	31	10 1 .0	19 37
Mean		$10^h\ 2^m.8$	$21°\ 29'$

The display on this morning was surpassed in 1898, but much exceeded those of 1897, 1899 and 1900.

On the 16th, as shown by the table, there was no marked display. Twenty-one paths were charted, from which the radiant point was found to be R. A. $10^h\ 4^m.3$; decl. $+21°\ 13'$.

The observations were made by Messrs. W. Upton, F. Slocum and J. Edwards of the Observatory, and W. S. Meader of the Friends School, Providence.

WINSLOW UPTON.

PROVIDENCE, R. I.

The October Meteors.—The 18th was cloudy. The 19th was clear after 1:00. The total number of meteors seen from 1:00 until 4:15 was 89. The meteors shot from radiants in Orion, Gemini, Leo, Aries, Taurus, Perseus.

From Orion	55
" Taurus, 1st radiant	4
" " 2d "	4
" Gemini	11
" Leo	3
" Perseus	5
" Aries	4
" Canis Majoris	1
" Pegasus	1
" Eridanus	1
Total	89

Magn.	−3	−2	−1	0	1	2	3	4	5	6	Total
No.	1	1	3	15	14	17	21	11	6		89

Number leaving trails, 20.

Time.	No.	Notes.	Time.	No.	Notes.
1:00—1:10	4	Cloudy	2:40—2:50	8	Max.
1:10—1:20	2	"	2:50—3:00	1	
1:20—1:30	1	"	3:00—3:10	5	
1:30—1:40	5	"	3:10—3:20	9	Max.
1:40—1:50	7	Max.*	3:20—3:30	2	
1:50—2:00	6		3:30—3:40	3	
2:00—2:10	2		3:40—3:50	4	
2:10—2:20	6	Max.	3:50—4:00	5	Max.
2:20—2:30	5		4:00—4:10	5	
2:30—2:40	2		4:10—4:20	4	
			4:20—4:30	3	

The radiants were as follows:

Orion	$6^h.8^m$	$+15°\ 6.2$	$+13°$
Taurus	4 .22	$+16\ 3.55$	$+18$
Gemini	6 .31	$+17° - 20°$	
Perseus	3 .59	$+39°$	

* Maximum of shoal. Average 25 an hour and one in every 2 minutes and a third.

There were some very curious meteors. One that shot from Pegasus, lit up Earth and sky like the new Moon, and as it died out curved so that it made a semi-circle. From Gemini two of the bright meteors were very curious. They started as lines and broadened as they shot. One, which was as bright as Venus made a triangle, another ended in a flash almost a degree in width. The Orionids themselves came in shoals, having a maximum every 20 minutes.

Almost every one curved. Three Leonids were observed. They were swift and left green trails. The Orionids were usually red or orange, leaving green trails when brighter than first magnitude. A good many were lost while recording others.

ROBERT M. DOLE.

91 GLEN ROAD,
JAM. PLAIN, Mass.

Meteors at Dunmore, N. W. Territory, British America.—I observed the meteoric shower here this morning. The night was calm, and the sky perfectly clear. The meteors were Leonids. At a few minutes past 2:00 o'clock a very brilliant one came from Leo, travelled south. Its path was not more than 10 degrees. It left a vivid trail which was visible for about 4 minutes.

At 4:10 o'clock was the most beautiful meteor I noticed. It came from near the sickle, travelling northwest. Its path was about 12 degrees. It burned with a brilliant bluish light. It left a very vivid trail which was visible for more than 20 minutes. A peculiarity of this one was the massing together of the trail which then appeared like a faint gloaming cloud. This floated slowly northward and finally disappeared.

Between 4:30 and 5:30 o'clock I counted 186. About four-fifths of these went north, northwest and west. The great majority of the meteors appeared to reach near the horizon before being extinguished.

J. SALLOMS.

DUNMORE, Nov. 15, 1901.

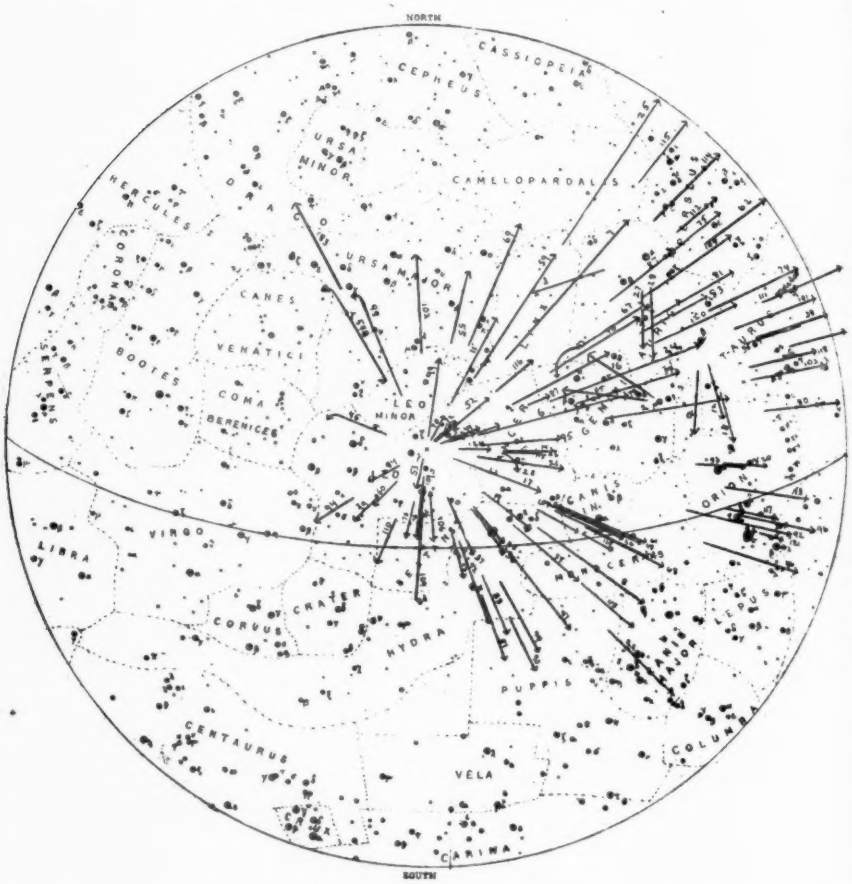
The Leonids, 1901.—Nov. 13 was cloudy all night. Nov. 14 was very clear. On Nov. 14 I observed 215 Leonids and 32 other meteors. On Nov. 15 I did not observe until 6:00. I saw two Leonids. On Nov. 16 it was cloudy about all night. At 2:00 it was partly clear. From 2:00 to 2:15 between the clouds I saw 5 Leonids and 2 others. Total 222 Leonids and 34 others.

Nov. 14	Leonids	Others	Nov. 14	Leonids	Others
12:00—12:15	1	4	3:15—3:30	11	0
12:15—12:30	3	0	3:30—3:45	15	0
12:30—12:45	3	3	3:45—4:00	10	0
12:45— 1:00	4	2	4:00—4:15	12	0
1:00— 1:15	6	0	4:15—4:30	14	0
1:15— 1:30	8	0	4:30—4:45	22	2
1:30— 1:45	3	5	4:45—5:00	26	2
1:45— 2:00	3	0	5:00—5:15	20	3
2:00— 2:15	4	3	5:15—5:30	14	0
2:15— 2:30	6	6	5:30—5:45	8	1
2:30— 2:45	5	1	5:45—6:00	6	0
2:45— 3:00	4	0			
3:00— 3:15	7	0	12:00—6:00	215	32
			Nov. 15	2	0
			Nov. 16	5	2
			Total	222	34

Number leaving trails, 116; average, 45 per hour; average, 1 in 1¼ minutes; maximum 4:30—5.00 = 68 + 7; largest number in an hour was from 4.15—5.15 = 106 + 7.

Magn.	6 = 0	Magn.	3 = 15	Magn.	0 = 46 (Capella)
"	5 = 14	"	2 = 54	"	−1 = 26 (Jupiter)
"	4 = 34	"	1 = 58	"	−2 = 3 (Venus)
					−3 = 2

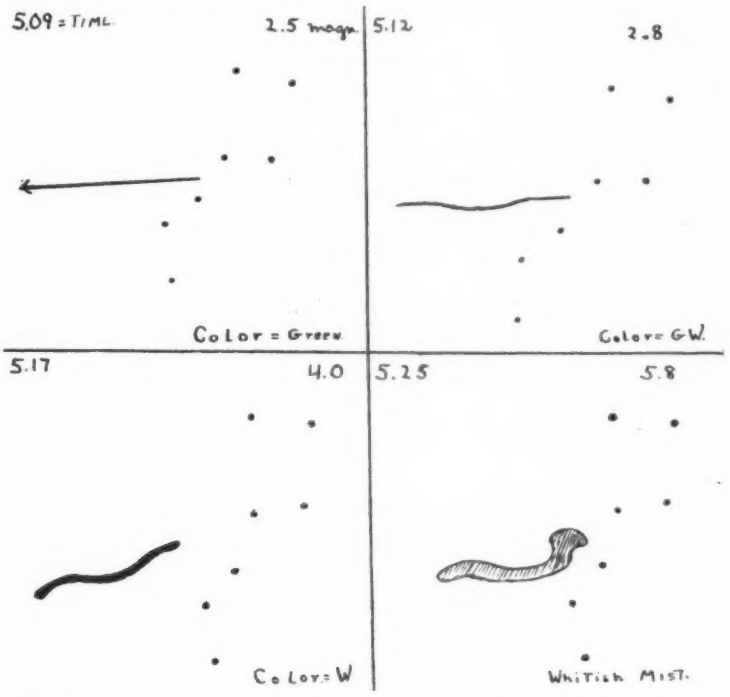
The number I lost while recording must have been over a hundred. Just before five there were 3 or 4 a minute. After 5:00 the number decreased very quickly. The maximum was about quarter of five. There was a large number of



LEONIDS CHARTED AT JAMAICA PLAIN, MASS., BY ROBERT M. DOLE, NOV. 14, 1901.

brilliant ones. The majority of the Leonids shot in a westerly direction. Some of the trails were very persistent. One or two lasted for five seconds. Two lasted especially long. One of 0 magnitude lasted 10 seconds. At 5:09 a splendid object shot through Ursa Major. It was much brighter than Venus and cast a dis-

tinct light over everything. It left a broad trail of 2.5 magnitude. This trail lasted 15 minutes. At first it was perfectly straight, then it bent in the middle NE.; then it assumed a figure like an *s*. As it grew fainter it was diffused over about a degree and a half. It was about 10 degrees in length. It changed from a green line, into a broad, faint band of whitish mist. It drifted about 2 degrees in all, NE. The time was 5:09—5:26.



CHANGES IN THE TRAIL OF A BRIGHT METEOR OBSERVED BY ROBERT M. DOLE, Nov. 14, 1901.

This year I observed over five times as many as in 1900. I believe that the maximum will occur in 1902 on the night of Nov. 14 between the hours of 14:00 and 18:00. The characteristics of the Leonids were: "They were usually very swift, with blue or orange-white heads, leaving green or blue trails. The shower was brilliant compared with 1899 and 1900. ROBERT M. DOLE.

91 GLEN ROAD, Jam. Plain, Mass.

Leonids Seen at Lincoln, Ill.—At $2^h\ 30^m$ in the morning of the 15th of Nov., the Leonids were very frequent. Between $5^h\ 36^m$ and $5^h\ 40^m$ I counted 13 Leonids in the region between Virgo, Leo, Orion and the southern horizon.

LINCOLN UNIVERSITY, W. P. RUSSELL.
Lincoln, Ill.

The Leonids.—Although no remarkable shower of Leonids was seen here, yet many meteors were observed on the morning of November 15th from $1^m\ 40^m$ to $4^m\ 45^m$, the majority of which were Leonids. The morning of the 14th was cloudy, and no meteors seen. The morning of the 15th was clear and the observer who was alone paid special attention to the constellation Leo in the vicinity of the radiant point. Seventy-six meteors were observed that started very close to the sickle. The majority of them I estimated at from third to fourth magnitude, and yellow in color. F. E. SEAGRAVE.

PROVIDENCE, Nov. 19, 1901.

Equatorial Diameter of Saturn.—One day during the early part of last summer while at the Harvard College Observatory, I happened to pick up a copy of the *Astronomische Nachrichten*, No. 3686-3687 and came across an article by Dr. See of the U. S. Naval Observatory on the dimensions of Saturn and his ring system. I made up my mind then that I would take some measures of the equatorial diameter of the planet myself at the July (1901) opposition. During that month and during the first three weeks in August the seeing was bad on nearly every clear night, and no measures were taken. From the 25th of August to the 8th of October there were sixteen nights when the seeing was good. The nights of Sept. 22d, 23rd, and Oct. 1st were the finest. The following observations were all made with the 8¼-inch Clark telescope, filar micrometer, power 385. They were all made by double distances. The results were sent to Dr. See of the U. S. Naval Observatory that they might be compared with his own observations made during the same period. The writer is under great obligations to, and wishes to thank Dr. See and Mr. Dinwiddie, of the Naval Observatory for their kindness in reducing these observations and in putting them into proper form for publication.

EQUATORIAL DIAMETER OF SATURN.

Date.	Time.	Micrometer Measures.			Seeing.
		Sets.	Mean.	Results.	
	h m		rcd.	″	
Aug. 25	7 40	6	1.486	17.95	Fair.
26	8 30	5	1.482	17.93	Good.
27	7 30	3	1.489	18.04	Fair.
Sept. 8	7 30	6	1.461	18.05	Good.
16	7 0	5	1.444	18.04	Fair.
21	6 50	6	1.419	17.88	Good.
22	6 30	9	1.403	17.70	Good.
23	6 30	7	1.390	17.57	Excellent most of the time.
24	6 30	4	1.375	17.41	Fair.
25	6 50	6	1.376	17.45	Good.
26	6 40	6	1.378	17.50	Good.
30	6 30	5	1.379	17.63	Fair. Bad at times.
Oct. 1	6 40	8	1.371	17.56	Excellent at times.
6	6 0	2	1.351	17.45	Fair.
7	6 20	2	1.348	17.44	Fair. Bad at times.
8	6 20	3	1.357	17.58	Bad.
				17″.696	

Value of one revolution of micrometer screw = 24″.459. F. E. SEAGRAVE.

PROVIDENCE, Dec. 7, 1901.

Position of the North Pole of Mars.—Some time ago I calculated the position of the north pole of Mars, using the following elements:

Long. ascending node of orbit	48°	45′	42″
" southern solstice	356	30	0
Inclination of orbit to ecliptic	1	51	2
" " equator to orbit	24	50	0

I found for position of pole R. A. 317° 56′ 23″ + 53° 33′

This position is 22′ 23″ farther east and 3° 28′ farther north than that found by Professor Oudemans, as given in Planet Notes for September. The longitude of node and inclination of orbit were obtained from the *American Ephemeris* (1897). Where I obtained the two other elements used, I am unable to say, having omitted to note authority.

This great difference in declination is probably due mainly to my using a smaller value for inclination of equator than was used by Professor Oudemans. Herschel's value according Proctor (*Encyclopedia Britanica*) was 28° 42′, and Bessel's may have been equally large.

G. SENECA JONES.

2136 Uber St., Philadelphia.

The Hastings-Brashear Photographic Lenses.—From an excellent report recently made by F. L. O. Wadsworth, Director of the Allegheny Observatory, which is connected with the Astronomical Department of the Western University of Pennsylvania, we take the following about photographic lessons in which Mr. Wadsworth says:

"During the year I have tested and reported upon a number of the large lenses and instruments recently constructed at Mr. Brashear's shop. These tests were conducted either at the request of Mr. Brashear or of the parties for whom the aparatus was constructed. Among the tests may be mentioned that of the new Universal Star Spectroscope of the Philadelphia Observatory, of the 8-inch objective of the same institution, and of the two 16-inch photographic doublets for Professor Wolf, of the University of Heidelberg. The latter, which were designated and computed by Professor Hastings, are, in my opinion, the best instruments of their class that had ever been constructed up to that time. They give a field of good definition over 7° in diameter or over twice the area of good field given by the Bruce 24-inch lens of the Harvard College Observatory. Some very fine and interesting star photographs were obtained with them. Careful tests have also been made of two of the best commercial photographic doublets in the market. Both were found inferior in performance to any of the recent Hastings-Brashear lenses.

"In the various lines of work mentioned above a total of 71 photographs were taken between October 21st, 1899, and April 5th, 1900. The longest exposure was $3^h\ 25^m$. It hardly need be added that the period mentioned is the most unfavorable part of the year for observation and much of the work has been greatly delayed in consequence. The conditions at the old Observatory are highly unfavorable to good photographic work, but my experience during the past winter has shown that good results can be secured by very careful development. Very prolonged exposures are, however, out of the question at the present site, and it is earnestly hoped that some provision may soon be made for establishing a station for this work far away from the glare of the city lights. Unless this is soon done, it must be left to others to reap the advantages arising from the use of the new lenses and plates that have been developed here."

Bulletin No. 11 of the Lick Observatory, which has just been issued, is of special interest to observers who use the micrometer. It contains a very valuable series of measures by Professor Aitken of double stars specially in need of measurement. The list comprises nearly two hundred objects, each of which with few exceptions has been measured on three nights. These pairs are selected from the catalogues of Struve, Burnham, Clark and others, and comprise a large number of the most difficult and interesting of the stellar systems. Many of them are too close or unequal for most telescopes elsewhere. Of course, the measurement of such pairs have all been made with the 36-inch refractor, using powers up to 2400 diameters. It is a permanently valuable contribution to the literature of this branch of practical astronomy.

Plane and Solid Geometry.—Professor A. W. Williamson, of Augustiana College, Rock Island, Ill., has prepared a new book of 233 pages covering the essentials of Plane and Solid Geometry. The plan of the book is the usual one, divided into books from I-IX inclusive. The first treats of figures bounded by straight lines, the second, the circle, the third, ratio, proportion, limits, fourth, area, proportional figures.

Under the head of geometry of space book five takes up lines and planes in space, polyhedral angles, six, surfaces and volumes of solids, seven spherical triangles and polygons, with supplement: Cavalieri solids, volumes and spherical pyramids and segments.

Under the head of miscellaneous two books. The eighth, symmetry, maxima and minima, construction and Algebraic expressions and loci of equations. Book nine deals with conic sections.

Then follows a general supplement in which some attention is given to tangents and normals, the cycloid, catenary, rays, volumes of paraboloids and spheroids, quadratrix, trisecting an angle, formulas of mensuration and a full index.

This new book is written on what is called a suggestive method, and is intended for a younger class of students than those books ordinarily prepared for the advanced class of the secondary schools, and yet there is enough matter in the new plan to occupy the best classes all the time that can ordinarily be allotted to this one branch. The author has evidently taken great pains to put all demonstrations in as concise and direct a form as possible. We think he has pretty well avoided ambiguity in seeking so much brevity. That is the danger when compressing the argument too much.

In the hands of a thorough teacher, as the author himself is known to be, there could be but little danger in the direction suggested. We have known the author as a mathematician and of his work as an instructor of mathematics for many years.

The wide scope of this new book, the plain and practical way the subject-matter is handled, and the simple and direct way in which he states mathematical truth are some of the good things that this new volume brings to those seeking instruction from it. Address, Professor A. W. Williamson, Augustiana College, Rock Island, Ill.

Errata.—The observation of Nova Persei March 9, 15^h by Olivier (POPULAR ASTRONOMY December 1901, p. 546) should read "$0.2 < \delta$; $0.3 < \epsilon$;" instead of "$0.2 > \delta$; $0.3 > \epsilon$". This makes the resulting magnitude 3.25 instead of 2.75.

In Mr. Denning's article last month, on page 488 line 4 from bottom (1830, Sept. 5) should be (1831, Sept. 5). Page 489 top line "$5^h\ 59^m\ 36^s.56$" should be $9^h\ 55^m\ 36^s.56$." Page 490 line 13 from top "described" should be "deflected."